THURSDAY, SEPTEMBER 23, 1915.

THE CITIZEN AND THE STATE.

(1) *Morals in Evolution: a Comparative Study in Comparative Ethics.* By Prof. L. T. Hobhouse. Pp. xvi+648. Third edition. (London: Chapman and Hall, Ltd., 1915.) 10*s.* 6*d.* net.

(2) *The Natural History of the State: an Introduction to Political Science.* By Prof. H. J. Ford. Pp. viii+188. (Princeton: University Press; London: Oxford University Press, 1915.) 4*s.* 6*d.* net.

(3) *Citizens To Be: a Social Study of Health, Wisdom, and Goodness, with Special Reference to Elementary Schools.* By M. L. V. Hughes. Pp. xvii+331. (London: Constable and Co., Ltd., 1915.) 4*s.* 6*d.* net.

(1) THE present world-struggle is likely to have among its far-reaching results a modification more or less profound in our concepts of both the bases and the standards of civilisation, of morality as a whole, of the State, and of education. Cultural values are in the crucible. The German point of view in each should not be either ignored or over-estimated; the German theory and practice of *Kultur* in war serves as a critical test and ordeal for Western civilisation generally. We speak of German immoralism and "Prussianism"; the Germans describe our own characteristic methods as hypocrisy and "muddling through." Whether these distinctions, if real, are the same as those between perversion and orthogenesis, autocracy and freedom, is an open question, but we can certainly learn from the enemy the lesson of applying science to every department of civilised life and organisation. And, after all, whatever the ideals of a people, it is doomed to stagnation unless its science is living, and is continuously informing every activity of national life. This may be considered an academic truism by the practical man, who is too often the unscientific man; but a truism is none the worse for being academic, and, if true, deserves a trial. The Germans have had the insight to try it, and they have had extraordinary successes therefrom. If these do not continue, it will be the fault, not of the application of science, but of German character and circumstances.

Some thinkers may have noticed how German crimes against human and international morality, such as the destruction of Louvain and the sinking of the *Lusitania*, have passed into somewhat of oblivion in the consciousness of neutral States and bodies, such as the U.S.A. and the Vatican, with a rapidity directly proportional to that of the immediate indignation which they aroused. It may be argued that this phenomenon is due to the absence of retribution, and the argument would be a significant criticism of world-morality. Prof. Hobhouse, in the new and third edition of his "Morals in Evolution," devotes some five pages to the question of punishment, whereas Prof. Westermarck, in his "Origin and Development of the Moral Ideas," devoted about a quarter of his space to it, roughly speaking, about five hundred pages. The significance of this contrast is perhaps to be found in the fact that the outlook of Prof. Hobhouse is philosophical, from the concept, that of Prof. Westermarck is from emotion. Of course, these views are not mutually exclusive, but most usefully mutually subservient. Prof. Hobhouse has practically rewritten his book, and has incorporated in it the investigations into the culture of the "simpler peoples," carried out by himself and Messrs. Ginsberg and Wheeler. This anthropological research on statistical lines enormously increases the value of the book. As before, the author's broad outlook is eminently sane; if he retains any prejudice, it is Hegelian, but one must have an absolute of some sort.

"That the moral standard of man is based on the character of man . . . is a principle which has been little understood in modern ethics." In order to see the genesis of morality the author goes to instinct. Instinct "is a name for human character as it grows up under the conditions of heredity, and it is from this character, with all the faults and foibles along with the virtues thereof, that the moral judgment issues. Human morality is as blind and imperfect as man himself." Sympathy or desire for reciprocal benefits are only small factors in the growth of morals. Again, though "the conception of the Good is the logical foundation of every rule of action . . . the standard of conduct may be affected by causes which are not ethical in origin, though they may come to have ethical consequences. . . . For example, a magical rite may be prescribed as a duty because it is believed to be efficacious in averting a calamity to one's self, one's family, one's society, as the case may be. If the belief in magic disappears, the performance of the rite will cease to be obligatory, although there may be no change in the current conception of the duties to society, family, or self." In this connection, the author has been very successful in estimating the part in morality played by the body of tradition.

With regard to the development of ethical conceptions, we are "constantly tempted to believe that an animal is guided by clear ideas, while the evidence when all put together goes to prove

that it is moving towards an end without clearly and fully apprehending what that end is. And when we have once grasped the possibility of this pseudo-purposive action, we are tempted to generalise it, and deny intelligent purpose in all cases." So the primitive mind is guided by feelings and impulses which it cannot fully understand, and observers may be misled so far as to assert that this or that tribe is destitute of all conception of right and wrong. From the beginning man has been bound by moral law, and the author finds, throughout, "a recurrence of the common features of ordinary morality, which is not less impressive than the variations." Yet, while "ethical progress is essentially a progress in ethical conceptions, acting through tradition," the question whether, "morally considered, the human breed has in fact improved" is difficult to settle. Here the researches of Freud into the nature of the "unconscious mind" would be in point, but "Morals in Evolution" is mainly a study in morphology. As such it is invaluable.

(2) Hegel argued that the State is the realised ethical idea. It is interesting that Hegel commenced the sequence of ideas of which Treitschke was the most spectacular exponent. Prof. Ford, of Princeton, has made "a detailed survey of connections between biology and politics inferable from the doctrine of Darwinism." He concludes that "the fundamental difference between Man and other mammalia is that he is distinctly a product of social evolution." "Man," as Profs. Geddes and Thomson have observed, "did not make society; society made Man"; "the individual," says Prof. Baldwin, "is the result of refined processes of social differentiation." Prof. Ford's book seems to be a series of lectures, based on appropriate quotations in biology, psychology, and linguistics, to contradict the theory of "individual evolution" so called. The State, as Aristotle said, is prior to the individual; language and social psychoses have helped to make the individual mind. There is a well-defined series of stages in the social organic evolution; phylogenetic theory passes into political science. The evolution of the State and the evolution of the individual mind are two aspects of one process, which starts from the human genius for social life. The chief interest of this view is in the relation between man's biology and psychology, and here the advocates of what Prof. Ford styles "the Social Hypothesis" have to assume a "psychological chasm" between man and the primates. Thus, if man's peculiar development of intelligence accounts for the beginnings of a social evolution superior to others, and if his peculiar intelligence is only to be explained by the action of his social evolution, there is a circular argument at the very starting-point of the hypothesis.

(3) In his preface to Miss Hughes's volume Prof. J. H. Muirhead observes that the war will pass judgment on two ideals of education, which are intimately bound up with the theory of the State and with the practice of government and citizenship. In the one there is "the disinterested development of the powers of the individual, to the end of giving him his place in a community of free and equal citizens with an outlook beyond to a world-order of like communities." In the other there is a community "narrowed down to a particular nation and state, carrying with it the regimentation of powers and the subordination of will to the end of its own particular purpose of racial predominance." Miss Hughes argues that the "root causes and the root cures of social evils are educational rather than economic," and she pleads for more of the humanist ideal in our educational system. Our elementary education has been adversely criticised; the author succeeds in pointing out its real merits and in proving many good results it has had upon our citizenship. The problem of the school is the problem of the nation, as the Greeks realised long ago. This enthusiastic teacher perhaps asks too much of the average mentality of the people, but not the least merit of her book is the wealth of practical suggestions which deserve the attention of all interested in education, since they are evidently inspired by a high idealism and based upon personal experience. A. E. CRAWLEY.

CHEMISTRY AND THE MICROSCOPE.

Elementary Chemical Microscopy. By Prof. E. M. Chamot. Pp. xiii+410. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1915.) 12*s.* 6*d.* net.

THIS book forms a welcome addition to the very restricted literature of chemical microscopy. It affords a considerable amount of information concerning the microscope itself, and its special adaptation to the purposes of the chemist and metallurgist. It also places at the disposal of the chemist the data for performing a large number of more or less trustworthy microchemical reactions. One notices immediately, however, a singular omission, that of any reproductions of either drawings or photomicrographs of the crystals produced in these reactions as observed under the microscope. A book on microchemical analysis without any indications other than verbal of the appearances seen under the microscope is surely like the play of "Ham-

let" without the title-rôle. Considering the excellent photomicrographical apparatus now available such an omission is not easy to understand. More than twenty years ago the reviewer prepared and showed to his students in the form of lantern slides numerous photomicrographs of the crystalline products of chemical reactions. The book of Haushofer (which does not appear to be mentioned at all by Prof. Chamot), published so long ago as 1885, although faulty in many respects, contained a large number of reproductions of careful drawings of the appearances on the microslip, and the later work of Behrens was also well illustrated in a similar manner.

Another defect obvious to British readers is the very slight mention of, or even complete omission of any reference to, much of the important work achieved by British workers in this domain, especially as regards instruments. For instance, the splendid crystallographic microscopes constructed in London by Swift are ignored, although, after using almost all the Continental microscopes, the reviewer considers no instrument can compare for efficiency or elegance with the later forms of the Dick microscope as made by Swift. Such omissions, however, are not at all uncommon in the recent books and memoirs of United States authors. For example, Prof. F. E. Wright, in a recent memoir on "A New Crystal-grinding Goniometer," an instrument for preparing accurately orientated surfaces on crystals, while making considerable reference to very inferior German apparatus, merely makes a footnote reference to the refined, rigidly stable, very efficient, and much more complete instrument for this purpose constructed long ago by Messrs. Troughton and Simms for the reviewer, and with which the thousands of section-plates and prisms have been prepared for his prolonged work on the sulphates and selenates and numerous double salts. Perhaps the lessons of the war will enable our cousins in the United States to appreciate more fully the important pioneer work in science done in this country, and to be less ready to accept the much more widely advertised German work as being alone worthy of consideration.

When such defects as have been referred to are discounted, a very valuable aid to chemical microscopy will be afforded by Prof. Chamot's book. One of the most interesting chapters is one on ultra-microscopes. It is shown that the ultra-microscope renders visible particles so minute that their diameters may be only slightly greater than the half-wave-length of the light employed, on the principle of the "Tyndall effect," that which is evident in the dust scintillations (diffractions) of a beam of light passing through an orifice into a darkened room. Good illustrations and explanations are given of the Cotton and Mouton, Cardioid, and Zsigmondy ultra-microscopes, the Jentsch ultra-condenser, and the slit ultra-microscope. There is, moreover, a good chapter on the determination of index of refraction by means of the microscope, and also one on attempts at quantitative analysis by the same instrument, including an account of the Barger method of determining molecular weights by micrometric measurement.

The small amount of crystallography, about a dozen pages, is both antiquated and not always accurate; no student could possibly obtain a true idea of the subject without previous or further study. In the preface Prof. Chamot states that his book is intended for students who have passed through a course in crystallography. If there should be many such happy students in the United States they are much more fortunate than their British cousins. Indeed this book only adds one more to the many examples for the very urgent need, both in America and in this country, for the provision of efficient instruction in a subject which is now an essential one to the correct understanding of either chemistry, physics, metallurgy, or any of their many specialised ramifications.

A. E. H. TUTTON.

MATHEMATICAL THEORY AND PHYSICS.

(1) *The Mathematical Analysis of Electrical and Optical Wave-Motion on the Basis of Maxwell's Equations.* By Dr. H. Bateman. Pp. vi + 159. (Cambridge: At the University Press, 1915.) Price 7*s.* 6*d.* net.

(2) *Homogeneous Linear Substitutions.* By Prof. H. Hilton. Pp. 184. (Oxford: At the Clarendon Press, 1914.) Price 12*s.* 6*d.* net.

ORIGINAL, and in fact fundamental, work in mathematics proceeds very rapidly in these days, and in so many departments, that even the expert mathematician frequently complains that it is impossible to keep pace with any but a restricted field. In these circumstances, we can well imagine the position of the unfortunate student who wishes to do mathematical work of a post-graduate nature, and even knows where his inclinations lie, but is appalled by the difficulty of discovering the present condition of any branch of the subject. There is room at present for many volumes which shall fulfil one or more of three main functions—collect together the fragments of a fundamentally important body of theory from their hiding-places in periodicals and text-books on other subjects, give the student exhaustive references to and criti-

cisms of the necessary literature, and specifically indicate the problems which are now awaiting solution. If only because they discharge these functions in two departments of mathematics which, in the opinion of the present writer, are the most difficult of approach by the student, the two volumes now under review have made a most welcome and timely appearance.

(1) The subject dealt with by Dr. Bateman is of very recent growth as such, and is of nearly equal interest to the pure mathematician and the physicist. The references to the workers in this department are sufficient to indicate this fact, and yet the author has been singularly successful in his effort to make the work intelligible to readers who lack a somewhat extended mathematical equipment. Several other branches of modern electrical theory are large enough to need a text-book of their own, such as the Principle of Relativity, and these branches, already provided for, the author does not touch in detail. In fact, the scope of the work is limited to such developments of the electro-magnetic theory as are directly concerned with the solution of the equation of wave motion—the "boundary problems" of the physicist. The theories of potential problems, the scattering and diffraction of waves by obstacles of various forms, the pressure of radiation, electrical vibrations on variously shaped bodies, are typical examples of problems which are admirably reviewed and discussed, not only from the strictly mathematical viewpoint, but with reference to the physical implications of the results. For example, such problems as the tails of comets, wireless telegraphy, and the residual blue of the sky, come within the scope of the volume, although the author is sometimes compelled by considerations of space to give only the general outlines, with the necessary references to enable the reader to pursue the subject. An excellent account of the theory of the various mathematical functions which are necessary is given when occasion arises, without, however, the existence theorems which would render the work unwieldy.

Perhaps the most interesting part of the book is at the end, where the question of possible structure in the æther is discussed. It is sufficient to say that the greater part of the work is Dr. Bateman's own, and the reader is assured of an authoritative treatment of a very fascinating problem. References are exhaustive throughout the book, which fills all the three needs specified in our first paragraph,

(2) The subject of Prof. Hilton's work has a more restricted appeal, and is still to a great extent a matter for the pure mathematician. But recently it has come into prominence in connection with electrical theory, and the appeal is widening. Prof. Hilton has in any case rendered signal service by collecting together, into a connected body of attractive theory, the branch of mathematics which has hitherto been most scattered, or only treated casually as a particular case of more general theory. He confines his treatment to those properties of substitutions which do not depend on "groups," and all such properties which are vital to the Theory of Groups, and the theories of Bilinear Forms and Invariant-Factors receive a satisfactory and connected account in this volume. The discussion of substitutions the determinant of which does not vanish is very complete, and those with a non-zero determinant are sufficiently introduced to the student. Important applications of the work are indicated, the examples are numerous, well graded, and very suitably selected, and there are very few misprints. A student who uses Prof. Hilton's book will find the subject very attractive and easy to assimilate. It should find a place in every college library.

The book is issued by the Clarendon Press, and Dr. Bateman's by the Cambridge University Press. Each volume maintains the best traditions of the series to which it belongs.

OUR BOOKSHELF.

La Science Allemande. By Prof. P. Duhem. Pp. 143. (Paris: A. Hermann et Fils, 1915.)

PROF. PIERRE DUHEM, member of the Institute, has printed four lectures which he gave to students at the University of Bordeaux. Their general aim was to deliver the minds of his hearers from subservience to German thought, and they certainly make for fresh air. The first deals with mathematics and philosophy, and its conclusion is that an excessive fondness for deductive method and a contempt for common sense have made intellectual Germany like the house of Chrysale, whence reasoning drove forth reason. Hegel's axiom as to the identity of contradictories is compared to that of Nicolas of Cues, often called the *cardinalis teutonicus*, that the maximum is always identical with the minimum. But this is surely playing to the gallery. The second lecture is devoted to the experimental sciences, and includes an interesting sketch of Pasteur's trial and error methods, a denunciation of Haeckel, and an assurance that Fabre's fine work has left us with scarcely more than the débris of the Darwinian theory. The exaggeration and misunderstanding involved in the last statement show us that the illustrious author has his obfuscating prejudices like the rest of us.

The best part of this lecture is its illustration of "*l'esprit de finesse*" in French science. The third lecture is on the historical sciences, and is full of righteous anger. It illustrates the

writing of history under the conception of "Deutschland über alles." And not only the writing of history, for it seems that German editions of Cæsar's Commentaries have been subjected to surgical treatment to make them conformable with the axiom. It is not to be supposed that Prof. Duhem has not respect for giants like Leibniz and Gauss; indeed, in the fourth lecture and the appendix, he gives (more philosophically than in the rest of the book) careful appreciation of the geometrical spirit which is at once the strength and the weakness of German science. Of this geometrical spirit English science is all but destitute; its strength is in intuition. The characteristic French qualities are order and clearness, and *l'esprit de finesse*; and each has much to learn from the others.

Mineral Resources of Minas Geraes (Brazil). By A. F. Calvert. Pp. xvi+100+127 plates. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1915.) Price 6*s.* net.

THIS little volume contains a eulogy of the mineral wealth of the famous State of Minas Geraes, the importance and value of which have long been well known to all who have studied, however superficially, the distribution of the world's mineral resources. The author appears to have searched diligently all available records of Brazilian mining and has evidently read widely and extensively; it is only a pity that he did not supplement his want of knowledge of technical matters by getting some competent mining engineer to revise his proof sheets. This would have saved him from repeating such a foolish criticism as that of Sir Richard Burton upon the shortcomings of the Brazilian miner:—"The Davy and the Geordie were equally unknown to him," the mines referred to being gold mines (!); it would have prevented him from persistently writing "phosphorous" instead of "phosphorus"; it would have most certainly corrected his version of the reports of Baron von Eschwege, from which it seems that the author is unaware that the German equivalent of "blast furnace" is "Hochofen," and that "high furnace" is a phrase that conveys no meaning to the British smelter.

Perhaps the most interesting sentence in the book is one in the preface, where the author summarises the causes that have led to the poor results obtained in Brazil, as a rule, from such great natural resources; he enumerates them as follows:—"Liberation of the slave workers, bad legislation and exorbitant taxation, lack of railway communication, political unrest and financial instability, and the incompetence and dishonesty that have attended the exploitation of the mines and the management of the companies that have been formed to work them," and goes on to point out that in his opinion these drawbacks are being steadily removed. Most British capitalists who have had experience of extensive business operations in Brazil would be disposed to add several very significant items to the above list, not the least important of which would be the rapid fluctuations in the rate of exchange.

LETTERS TO THE EDITOR.

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Magnetic Measurements.

WITH reference to the very kindly review in NATURE of July 29 of "Electrical Instruments in Theory and Practice," by Mr. U. A. Oschwald and myself, your reviewer takes exception to the suggestion on p. 32 and elsewhere that "in view of its great simplicity the method of testing by the magnetometer ought to be more used than at present."

The reason urged for the rejection of magnetometer methods is that disturbances from neighbouring current-carrying conductors would render it useless, and presumably ballistic, or other methods should be used instead.

I wish to point out on behalf of Mr. Oschwald and myself that we did not suggest the adoption of magnetometer methods in any haphazard way. Both of us have had considerable experience of magnetic work, and the suggestion was made for the following reasons

(1) In ballistic work, if a Thomson moving needle galvanometer is used, as is frequently the case, the same sources of error are present.

(2) No ballistic galvanometer can be calibrated very accurately at present. The values of the constant as determined by Messrs. Hadfield and Hopkinson (Journal Inst. Electrical Engineers, vol. xliv., p. 270) by condenser, standard field, and steady deflection, differ amongst themselves by about 1 per cent.; and there are generally other sources of error in magnetic work.

Now, when electric light wires are laid in a building, the flow and return wires are generally close together in casing, or iron tubing, so that the effect with any reasonable precautions is *less* than 1 per cent. Hence the method is practically equal to the ballistic one, so far as accuracy is concerned.

Again, for rapidly *comparing* specimens of iron by the zero method, the objection vanishes, and there is nothing to approach the magnetometer for this purpose.

In my opinion, the ballistic galvanometer is a considerably overrated instrument for this purpose, due possibly to the fact that errors in its constant are conveniently forgotten in the course of research.

Apart altogether from accuracy, there is the outstanding feature of the simple magnetometer, viz. that it measures directly the forces we are dealing with, whereas the ballistic method depends on measuring another quantity altogether. I think I am not wrong in hoping that the magnetometer will be partially restored to its ancient position as the premier magnetic testing instrument.

W. H. F. MURDOCH.

September 3.

WITH reference to Mr. Murdoch's letter on the magnetometer method of testing iron, I described it as an admirable method under suitable conditions. I tried the method about three years ago in my laboratory, which is close to a track return tramway line, and had great trouble with it owing to zero fluctuations. The same difficulty has been found in other laboratories close by, where instruments with very weak magnetic control have been set up. I did not take exception to the suggestion that the

magnetometer method might be used more than it is at present *under suitable conditions*; I wished to direct attention to its practical limitations.

THE REVIEWER.

Nodules on the Intermediate Bladderwort.

I RECENTLY had an opportunity of examining living specimens of a very rare British plant, the intermediate bladderwort (*Utricularia intermedia*), and found that the leaf-bearing stems ended in a solitary terminal knob or nodule, the largest being the size of a small peppercorn. What are these knobs? Are they autumn plant-buds that will ultimately grow into plants? This seems to me a possible solution; but (my edition of) Bentham does not mention that the plant propagates itself in this way, nor are the knobs figured in the companion volume of illustrations by Fitch and Smith. HAROLD EVANS.

Llanishen, Cardiff, September 17.

NOTES ON STELLAR CLASSIFICATION.

III.

IN the year 1890 a photographic study of the spectra of stars was commenced by me at the Solar Physics Observatory at Kensington. The object of the investigation was not so much to make a spectroscopic survey of the stars generally as to examine with considerable dispersion the spectra of the brighter individual stars. Up to the end of the year 1900 there had been accumulated a large number of spectra, a catalogue of which was published in the year 1902. This contained 470 of the brighter stars.

In this catalogue the stars were classified according to their spectra after a minute inquiry of the lines due to each of the chemical "elements" involved.

The spectra of 105 of these 470 stars were photographed by Dr. F. McClean at the Cape Observatory.

Details of this classification were given in the publication above mentioned, but a brief summary may here be given. The stars were arranged in two main groups, one in which the stars were getting hotter ("hotting"), and the other in which they were cooling. The differentiation of these two groups was based, not only on their chemistry, but on other differences observed on the two arms of a "temperature curve."

On the temperature curve the stars increasing their temperature were located on the left-hand branch or ascending arm of the curve, and the cooling stars on the right or descending arm. The stars of the highest temperature were located at the apex of the curve.

The two main divisions of stars, *i.e.* those getting hotter and those getting colder, were each classified according to their chemistry and placed at their respective levels on each side of the temperature curve. At equal levels on each arm the stars were considered to be of the same temperature, each group being designated by a name derived generally from that of the "type star" which had been selected to represent that group.

Further experience with this method of stellar classification led to the detection of criteria which have suggested the interpolation of additional groups, and those have now been embodied in the general scheme as given below representing the classification in use at present, and to it has been added the Harvard scheme of classification of the type stars employed by me.

Harvard Classification			Harvard Classification
Oa Pec. Od	Argonian		
Oe5		IV	
B	Alnitamian	III	
B		II	
B		I	
B2	Crucian	Achernian	B5
B3	Taurian	Algolian	B8
B8 Pec.	Rigelian	Markabian	A
A2 Pec.	Cygnian	Sirian I	A
	—	Sirian II	A5
F8 Pec.	Polarian	Procyonian I	F5
G	Aldebarian II	Procyonian II	G
K5	Aldebarian I	Arcturian	K
Ma	Antarian	Piscian	N

The main routine work at the Hill Observatory at Sidmouth, since the McClean telescope was brought into use in September, 1913, has been a spectroscopic survey of all stars down to the fifth magnitude other than those published in the above-mentioned catalogue; incidentally the spectra of a number of stars fainter than magnitude five have also been photographed.

This programme of work is especially fitting for this observatory, because the same instrument is in use which Dr. Frank McClean employed in his spectroscopic survey of stars equal to or brighter than magnitude 3·5, the telescope having been presented to the observatory by his son, Frank Kennedy McClean.

The McClean instrument consists of an equatorially mounted twin-telescope with apertures of 12 and 10 inches, and focal lengths of 134 and 150 inches respectively. The former is fitted with an objective prism of 12 inches aperture and 20° angle, and is mounted in a metal frame in such a way that it may be moved clear of the objective. In the focal plane is placed a camera fitted with a swing back by Messrs. Hilger. This carries a plate-holder for plates $6\frac{1}{2} \times 4\frac{3}{4}$, but an adapter has been inserted to carry plates $4\frac{1}{4} \times 3\frac{1}{4}$ which are in use. The dispersion on the photographic plate between K and Hβ is equal to 28 mm. or 927 Ångström units.

The telescope, built by Sir Howard Grubb, of Dublin, is driven by means of falling weights, and is fitted with electric control movements regulated by an electric pendulum. The governor is of the heavy ring pattern, and is adjusted by means of a cam. The declination circle is electrically illuminated, and viewed with the aid of one of two reading telescopes from the camera end. In addition to two finders of 4-inch and 2-inch aperture fitted to the 10-inch tube, a 3-inch finder deviated to the angle of the prism has been specially attached to the tube of the 12-inch; this serves the purpose of observing the amount of

clock rate and for "following" in the case of photographing the spectrum of a comet.

In order to obtain a serviceable width and the necessary density to the spectra, a rate of acceleration or retardation is given to the driving clock. This rate depends on the magnitude of the star in question, its type of spectrum, and its declination. The adjustment for rate is accomplished by regulating the speed of the governor ring by means of the cam mentioned above, the indicator being set to readings which have been derived from previous photographs.

The McClean telescope is mounted on three concrete pillars in a building with a circular concrete-block wall, internal diameter of 18 ft., on which is a hemispherical dome made of wood and covered with rubberoid. The wall is double—that is, has an air space in order to prevent rapid changes of temperature of the air in the dome. The dome rests on iron wheels running on a circular rail fixed to the upper part of the wall, and is easily revolved by hand by means of an endless rope round a grooved pulley fixed to the axis of one of the wheels. The shutters, also operated by hand, are made in two sections and run on rails at their upper and lower extremities; when open, a clear view of the zenith is obtained.

All the electric connections for the telescope and lighting purposes and for the driving-clock wire are led in a trough into an annexe in which are placed the electric pendulum, small accumulators, dark room, etc.

The building is situated on the top of Salcombe Hill to the east of Sidmouth; it is 580 ft. above sea-level, and commands an uninterrupted view of the horizon in every direction.

Since the instrument was first brought into use in September, 1913, the site has been found to have all the excellent observing conditions that were anticipated.

Smoke, mist, artificial-light glare are conspicuous by their absence, and on only one occasion has high wind in a clear sky prevented observation. The hill-top is often clear when the adjacent valley is filled with mist or cloud. Cloud on the top is rare.

The purity of the sky on almost all occasions when free from clouds is extremely advantageous for photographic observations. At South Kensington such clear, dark skies were extremely rare, and then only one or two hours in the early morning were at all comparable with the conditions here. The excellence of the atmospheric conditions is well shown by the extension of the spectra into the ultra-violet. A spectrogram of α Cygni taken with the 9-in. Henry prismatic camera shows the hydrogen series down to H_∞ (λ 3667·8), *i.e.* twenty-three hydrogen lines on the one plate. The most refrangible hydrogen line recorded in the South Kensington reduction of the spectrum of α Cygni was H_θ (λ 3798). It may also be mentioned that the southern stars α Columbæ (dec. −34° 8′) and λ Scorpionis (dec. −37° 2′) have been seen with the naked eye. The steadiness of the image is normally greater than at South Kensington, and long exposures on faint stars give spectra showing definition of a very satisfactory character.

The working list prepared for use with the 12-in. McClean instrument contains all the stars of the Harvard revised photometry of magnitudes fainter than 4·0 and brighter than 5·0 to the north of dec. −15° which were not included in the catalogue of 470 brighter stars compiled at South Kensington. For these stars exposures of twenty minutes to one hour, according to magnitude and type, are usually amply sufficient to yield spectrograms of sufficient width and density to exhibit enough detail for the purpose of classification. Neighbouring stars fainter even than 6·0 magnitude are sometimes satisfactorily recorded.

A catalogue of the stars the spectra of which have been photographed and classified since 1913 at the Hill Observatory has been prepared; it contains 354 stars. The designations, positions for 1900, magnitudes, and Harvard classification have been taken from the Revised Harvard Catalogue (Annals of the Astronomical Observatory of Harvard College, vol. iv.). In the last column of the table is given the equivalent Kensington classification. The small letters *h*, *c*, and *a* indicate whether the star is increasing its temperature (hotting) (*h*), decreasing its temperature (cooling) (*c*), or at the apex (*a*) of the temperature curve or about the condition of being most hot. The letter (*p*) denotes that there is some peculiarity about the spectrum.

These small letters will save references to the groups in my classification in the case of those inquirers chiefly interested in temperatures. They also show that the Harvard classification includes both classes of stars under the same designation in the other cases.

Before the war Lieut. Lockyer, R.N.V.R., and Mr. Johnson and Mr. Goodson were the assistants engaged in photographing and classifying the spectra. Since Lieut. Lockyer and Mr. Johnson took up their military duties, their work has been carried on by Mr. Goodson.

NORMAN LOCKYER.

THE ATTACKS OF BIRDS UPON FRUIT.

UNDER the heading of "The Ravages of Birds" a correspondence has arisen in the *Times* which is apt to mislead both the general public and fruit-growers on a subject already overburdened with misrepresentation and error.

It is suggested by one correspondent that there are two simple methods for preventing the attacks of birds upon fruit, viz., (i) provision of drinking water, (ii) provision of food to entice the birds away from the fruit. That there may be a scarcity of water in some districts is quite possible, but at the time when the missel thrush, blackbird, blackcap, bullfinch, etc., attack fruit there is an abundance of animal food in the form of insect larvæ, insects, worms, slugs, snails, etc., in addition to wild fruits and seeds. Further, if a few of these fruit-eating birds are shot, and the

stomach contents examined, it is surprising how little fruit-pulp is found. Again, if blackbirds are kept in confinement and fed on similar ripe fruit very little is consumed.

Careful observation and experiment have shown that in most cases where ripe fruit is attacked it is not due to a scarcity of food, and that very much more fruit is damaged than eaten. In different parts of the United States it has been found that the provision in orchards of water has considerably lessened the damage by birds to the fruit.

Mr. G. F. Burgess, another correspondent, asks, "If the birds need water, why provide food? If it is food they want, why provide water? It is quite possible," he continues, "that the birds acquired the 'fruit habit' in times of drought, but the habit is now so well established that the damage goes on in wet and dry seasons alike." This brings us much nearer the actual truth. A supply of water may keep young birds away from the fruit in times of drought, but once a bird acquires the fruit-eating habit, experience shows that nothing will change it.

This change of habit in the nature of the food opens a big question, and one around which much controversial matter ranges, but where cases have been subjected to careful investigation by competent workers one striking fact has been brought out, viz., that the particular species of bird or birds had been allowed to increase unduly, and is now too plentiful. This has been proved in the case of the cereal-feeding habit of the rook,[1] and the fruit-eating habit of the blackbird and missel thrush.

It seems surprising that, in a country where the question of producing the maximum amount of home-grown food is one of vital importance, so many economic problems related thereto have been almost entirely neglected. We are offering protection to certain injurious wild birds and permitting other beneficial species to be wantonly destroyed, with the result that food to the value of tens of thousands of pounds sterling is annually destroyed. That the same thing is taking place in connection with our fisheries there is good reason to believe.

In other countries the State has made provision for systematic and continued investigation on the subject, much to its material benefit, but as a writer has recently very pertinently stated, "In the matter of economic ornithology we in England are disgracefully behind the times; the Board of Agriculture seemingly prefers to leave this matter to private enterprise, or to deal with the matter in such a perfunctory manner as to be positively ridiculous, making us the laughing-stock of the nations."[2] In the past the want of financial means has been the excuse, but the present apathy can scarcely be due to that cause, seeing the manner in which huge sums are being used out of the Development Grant for far less important purposes.

WALTER E. COLLINGE.

[1] "The Food of Some British Wild Birds." (London, 1913.)
[2] *Ann. and Mag. Nat. Hist.*, 1908 (s. 8), vol. ii., p. 132.

NOTES.

AMONG those who were on board the *Royal Edward* when she was torpedoed and sunk in the Ægean Sea was Capt. Charles Bertram Marshall. When last seen he was standing on the deck giving orders to his men to keep cool; and he seems to have died as he had lived, a brave, generous, and unselfish man. Although Capt. Marshall had no intention of devoting himself to purely scientific pursuits, he belonged to that too rare class of medical men who, before embarking upon the practice of their profession, endeavour to obtain a thorough all-round training in the ancillary sciences and experience in original research. In addition to the customary series of hospital appointments, Dr. Marshall held a demonstratorship in anatomy in Manchester University, and carried out a successful investigation in reference to the movements of the stomach and the chemistry of the digestive processes, for which he received the M.D. degree with commendation. He was a man of exceptional ability and charm of character, and he gave promise of accomplishing much in the advancement of the science of medicine.

WE regret to see the announcement that Lieut. J. A. Dixon was killed at the Dardanelles on August 9. After a first season's work in Nubia, he took part in the expeditions sent to Abydos in Upper Egypt by the Egypt Exploration Fund in the winters 1909–10 and 1910–11, in the capacity of draughtsman and assistant excavator. The illustrations of the volumes dealing with those expeditions are a sufficient testimony to the amount and quality of his work. His ambition, however, was to make a name for himself in the field of copying in water colours the scenes which adorn the rock tombs of Thebes, and his first efforts in this direction had met with considerable success. In the desert camp, where the qualities of a man are tried to the utmost, he was a keen worker and a bright and frank companion, generous to the last degree. He loved Egypt and everything in it, from the luxury of a Cairo hotel to the discomfort of the excavator's camp. His treatment of natives was ideal: sympathetic, just and friendly, and yet with that background of firmness which too many Europeans lack, but which is, in truth, the only passport to the respect and admiration of the Arab. Since 1912 he had been connected with the expeditions of Mr. Wellcome in the Sudan, but there is little doubt that his heart was in Egypt proper, and that, had he lived, he would have contrived to return to his painting among the Theban tombs.

MR. CLAUDE GRAHAME-WHITE and Mr. Harry Harper contribute to the *Fortnightly Review* for September an interesting account of "Zeppelin Airships: their Record in the War." It is refreshing to find an article on aircraft, especially Zeppelin airships, which is not full of that nonsense which the present conflict has inspired in overflowing measure. A highly-complex technical problem such as the airship presents is not readily made clear to the lay mind, and the authors of this article give only slight space to a discussion of technical questions of construction,

confining themselves to a consideration chiefly of the Zeppelin airship as a weapon of war. This aspect, while fascinating to the layman, is to the average technical mind much the least attractive avenue of speculation and inquiry, seeing that difficulties which can be comfortably overcome by a peace-airship are quite insuperable in one for use in offensive operations. It is easy to conceive airships in the future having sufficient strength to withstand all ordinary weather, but it is frankly impossible to conceive an airship that will stand any chance of surviving the anti-aircraft gunnery of the immediate future, provided it can be seen by the gunner. For offensive operations of value, the airship cannot avoid being in sight of the ground, and consequently it will be unable to undertake such operations. All war, however, does not consist of fighting, and there is plenty of scope for the excellent qualities of lighter-than-air aircraft in reconnaissance and so forth. It is a pity that so much ill-informed matter has been written about Zeppelins as aerial "Dreadnoughts"—in point of fact, there is very little else they can do when attacked but run away. The authors of this article are to be congratulated on the sane aspect of the case they have presented.

DURING the recent meeting of the British Association, the members were invited by the Manchester Literary and Philosophical Society to visit its house in George Street, Manchester. Particular interest is attached to this house, since it was for many years the scene of the labours of John Dalton, and contains a collection of his apparatus, lecture diagrams, notebooks, and manuscripts. This collection, along with other treasures belonging to the society, was set out for exhibition, and was described to the visitors by Prof. W. W. Haldane Gee. The apparatus, which is in a remarkably good state of preservation, includes a valuable collection of instruments used by Dalton in his researches and in his lectures on chemistry, heat, light, sound, electricity, mechanics, meteorology, and astronomy. The diagrams, many of which refer to the atomic theory, are those used by Dalton to illustrate his lectures. They are described by Prof. W. W. Haldane Gee, Dr. H. F. Coward, and Dr. Arthur Harden in a "Memoir" of the society. The notebooks, manuscripts, etc., which are also described in the "Memoir," show the nature and scope of Dalton's lectures, and give some interesting information about his expenses. The Manchester Literary and Philosophical Society is one of the oldest scientific institutions in the world, and has held its meetings in the house in George Street for nearly 120 years. The list of its past presidents includes such illustrious names as James Prescott Joule, John Dalton, Sir William Fairbairn, and Sir Henry Roscoe. The society possesses a very valuable library, which includes a collection of the publications of almost all the important scientific societies from their foundation.

A TABLET was unveiled on September 18 in Cheltenham College Chapel, and a life-size portrait by Mr. Hugh Riviere in the College Library, to the memory of Dr. E. A. Wilson, who perished with Captain Scott in the Antarctic. The late Dr. Wilson was educated at Cheltenham College.

AT the sale by auction of the Amesbury Abbey estate on September 21, the historic monument of Stonehenge was purchased for 6600*l.* by a local landowner, Mr. C. H. E. Chubb, of Bemerton Lodge, Salisbury. The estate came into the market in consequence of the deaths of Sir Edmund Antrobus and of his only son, who was killed in action last October. As Stonehenge is under the protection of the Ancient Monuments Act, no steps can be taken by the owner to alter or remove any parts of this remarkable relic of antiquity.

ACCORDING to the *Morning Post* correspondent at Christiania, a telegram from Archangel to the Foreign Office there states that the *Eclipse* Expedition, under Commander Sverdrup, has returned, and that all on board are safe. Commander Sverdrup left Christiania on July 15, 1914, at the request of the Russian Government, with the object of seeking for traces of the Russian expeditions under Brusiloff and Rusanoff, which had been lost in the Polar regions. He wintered in the western portion of the Taimyr Peninsula, and engaged in exploration work during the succeeding summer, but found no traces of the missing Russians.

SIR FREDERICK DONALDSON, Chief Superintendent of Ordnance Factories, has been appointed to act for the time being as technical adviser to the Ministry of Munitions. In the meantime, arrangements have been made for Mr. V. L. Raven, chief mechanical engineer of the North-Eastern Railway, whose services have been temporarily placed at the disposal of the Minister of Munitions by the board of directors, to perform the duties of acting chief superintendent of the Royal Ordnance Factories, Woolwich.

THE Minister of Munitions of War, with the concurrence of the Home Secretary, has appointed a committee to consider and advise on questions of industrial fatigue, hours of labour, and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops. The committee is constituted as follows:—Sir George Newman (chairman); Sir Thomas Barlow, Bt., K.C.V.O., F.R.S.; G. Bellhouse; Prof. A. E. Boycott, F.R.S.; J. R. Clynes, M.P.; E. L. Collis; Dr. W. M. Fletcher, F.R.S.; Prof. Leonard E. Hill, F.R.S.; Samuel Osborn, J.P., Sheffield; Miss R. E. Squire, and Mrs. H. J. Tennant. Mr. E. H. Pelham has been appointed secretary to the committee; and all communications should be addressed to him at the offices of the Board of Education, Whitehall, S.W.

THE nature and limitations of portable fire-extinguishers were dealt with in articles in NATURE of June 3 and July 22. Sir Edward Henry, the Commissioner of Metropolitan Police, has now repeated a warning issued on June 28 that chemical liquid fire extinguishers should not be purchased without a written guarantee that they comply with the specification of the Board of Trade, Office of Works, Metropolitan Police, or some approved fire prevention

committee. Many dry powder fire extinguishers are much advertised. The Commissioner warns the public, as the result of experiments made at his instance, by a competent committee of experts, that no reliance can be placed upon such appliances for effectively controlling fires such as are likely to be caused by bombs—explosive or incendiary. The Commissioner is advised as the result of these experiments that the provision, and prompt and intelligent use, of water or sand or of both in dealing with such outbreaks of fire is the best, simplest, and most economical safeguard.

THE United States National Museum, Washington, has recently obtained the greater part of a fine skeleton of Mastodon from a swampy deposit near Winamac, Indiana. The bones are in a good state of preservation, and when prepared will be mounted for exhibition.

THE eighth number of the *Boletin* of the Sociedad Physis of Buenos Aires, just received, completes the first volume of this publication. The society was founded in 1912 for the promotion and diffusion of natural science in the Argentine Republic, and has met with considerable success. All the published papers record the results of original research, and each part of the journal concludes with a useful series of reviews and notices of writings dealing with the geology, botany, zoology, and anthropology of South America.

DR. J. W. FEWKES, of the U.S. Bureau of Ethnology, has started to continue his exploration of the remarkable ruins in Mesa Verde National Park in south-west Colorado, which are believed to be the work of the ancestors of the modern Pueblo Indians. One of these constructions, known as Spruce Tree House, resembles a gigantic hotel built in a cave, the floor of which is about 50 ft. above the bottom of the canyon, while the roof is 80 ft. high. In some places the rooms occupied three stories, and the building may have accommodated 350 persons. Cliff Palace is nearly three times the size of Spruce Tree House, and, like it, stands in a cave to which access is gained by steps cut in the rock and by ladders. An important part of this structure is a ceremonial chamber entered from a subterranean passage. Here it is believed that the tribal ceremonies were performed. These structures, when fully excavated, will throw much light on the social life, religious and secular rites of this remarkable people.

WE have received a copy of the Madras Agricultural Calendar for the year 1915–16, issued by the Madras Agricultural Department, which contains a series of useful articles on green manuring, cotton and its cultivation, on various veterinary subjects, and on native implements and subjects of value to the small proprietor. The calendar portion gives information about cattle fairs and other matters of native interest, and, by way of introduction, the purpose of the Agricultural Department is fully explained.

THE first number of the Journal of the Botanical Society of South Africa has recently been published under the editorship of Prof. H. H. W. Pearson, hon. director of the National Botanic Gardens, Kirstenbosch. It includes a short notice of the late Lord de Villiers, the first president of the society, to whose interest and influence the establishment of the gardens and the founding of the society was so largely due. An interesting account of former public and private acclimatisation and botanic gardens at the Cape, with an outline of the establishment in 1913 of the National Garden at Kirstenbosch, is also given. It is a matter of regret that this important enterprise seems likely to suffer financially owing to the war, just when funds are so essential for furthering the initial stages of its development. It is to be hoped that the Botanical Society, to the assistance of which the new National Garden owes so much, will continue to bear its share in the responsibility of developing the Garden as generously as in the past, and will be able to enlist many new members to help on the work.

THE Transactions of the Royal Scottish Arboricultural Society, vol. xxix., part ii. (July, 1915), contain several articles dealing with larch, the most interesting being an account of the first-generation hybrids between the Japanese and the European species, which are making astonishingly rapid growth on two estates in Perthshire, where they originated a few years ago. A new species, *Larix olgensis*, from eastern Asia, is described and figured; but it is not considered likely to be of any value for economic planting. Mr. Marshall, who has extensive plantations of larch in the Lake district, gives the results of experiments, which show that the wood of the Japanese larch is considerably inferior in strength to that of the European species, at any rate when young and of a size only big enough for pitprops. The Transactions contain useful notes on various insect and fungus pests. It is satisfactory to learn that new regulations of the Postmaster-General facilitate the purchase of home-grown Scots pine for use as telegraph poles.

THE number of species of Ficus at present known from tropical Africa is 173, and the genus has recently been revised for the "Flora of Tropical Africa" by Mr. Hutchinson. Descriptions of the new species, illustrated in many cases by useful text figures, are given in *Kew Bulletin* No. 7, 1915. Our knowledge of the genus has been increased mainly owing to the collections made by Dr. J. Mildbraed, and to the extensive material sent to Brussels from the Belgian Congo. The genus is broken up into five subgenera; four of these have the bracts of the ostiole of the receptacle spread horizontally across the mouth, so that some of them are visible from the outside; but in the fifth subgenus, Bibracteatæ, containing 73 species, the ostiole from outside looks like a single pore-like slit, as all the bracts are abruptly reflexed and point vertically downwards into the receptacle. The present paper deals mainly with species belonging to this subgenus.

"THE Trees and Shrubs of the Pacific Coast" is the title of an interesting paper by Mr. F. R. S. Balfour, printed in the Journal of the Royal Horticultural Society, vol. xli., part i., August, 1915, which

was delivered as a lecture before the society in April of this year. The paper is illustrated by a number of excellent reproductions of the trees and shrubs mentioned in their native habitats from Vancouver to California. The region near Mount Rainier, discovered by Vancouver in 1792, is the home of many fine conifers, notably *Abies nobilis*, *Thuya gigantea*, Douglas firs, etc., and a number of interesting shrubs, seeds of which were collected by Mr. Balfour. The Siskiyou Mountains, on the borders of S. Oregon and N. California, were also visited in order to see that rare and interesting conifer, *Picea breweriana*, the weeping spruce, of which some excellent photographs are reproduced. Possibly not more than 5000 trees of this species exist in the wild state, but it has now been introduced to Britain, and the young trees are thriving well. The drooping branchlets, some 6-8 ft. long, hang down like those of the weeping willow. The last region described in the paper is the Monterey district of California, the home of those well-known and useful conifers *Pinus insignis* and *Cupressus macrocarpa*. The latter is illustrated by photographs of picturesque old specimens. These trees, the native habitat of which is now a very restricted area, were long ago introduced to Europe, Chile, New Zealand, and the Cape, where they are thriving as in their native country.

Lignum nephriticum, the wood which, infused with water, yields a yellow solution possessing a remarkable blue fluorescence, has been an object of interest ever since it was first brought to Europe from Mexico, soon after the discovery of America. Robert Boyle made a systematic study of the solution in 1663, which may be regarded as the first serious investigation of the phenomenon of fluorescence, but considerable doubt has existed as to the exact scientific identity of the tree yielding the wood. The most recent contribution to the history of *Lignum nephriticum* is published in the Journal of the Washington Academy of Sciences (vol. v., No. 14, August 19, 1915) by Mr. W. E. Safford. He gives the name *Eysenhardtia polystachya* (Ortega), Sargent, to the tree, and states that its botanical identity has remained uncertain until the present time. This statement, however, is scarcely correct, since the tree was referred to the genus Viborquia by Ortega, a name superseded by the later name of Eysenhardtia of Humboldt, Bonpland, and Kunth. These authors correctly named the plant *E. amorphoides* in 1823, and Mr. Safford, following Sargent, merely restores Ortega's old specific name, *Viborquia polystachya*, making *Eysenhardtia amorphoides* a synonym of *E. polystachya*. The story of *Lignum nephriticum*, with an account of its remarkable properties and its synonymy, was set out at some length in the *Kew Bulletin*, 1909, pp. 293–305, by Dr. Stapf, and Mr. Safford adds very little to the account there given. His paper is of value, however, because he reproduces Ortega's original illustration of *Viborquia polystachya* and also a photograph of specimens recently collected at Tamaulipas, Mexico. It was owing to its supposed diuretic properties that the wood of this leguminous tree received the name *Lignum nephriticum*.

WE learn with regret that a heavy gale which passed over the island of Dominica caused a considerable amount of damage to the Botanic Garden. About 100 trees, some of large size, were uprooted, and many others are reported to have had their tops blown off or to have been seriously damaged by the loss of branches. Unfortunately, a number of species of rare trees represented in the Garden by only a single specimen have been destroyed. The clearing of the devastated area will be a work of many weeks, and at least a generation must elapse before the Dominica Gardens can be restored to their former interesting and beautiful condition. Some of the lime estates in the island were also badly damaged, not only owing to the loss of crop, but also by the uprooting of a considerable number of trees.

IN Bulletin No. 47, issued by the Agricultural Research Institute, Pusa, Mr. Peter Abel describes a tour of the sugar factories in the Bihar district of northern India, made at the invitation of the Indian Government, with the object of advising on the machinery in use and the general management of the plants. Judged by the standard of the West Indies and America, these Indian factories are small, and run on such primitive lines that many of the labour-saving devices generally used in the west are not applicable. The approaches and exits were in most cases badly arranged, resulting in blocks and confusion of the bullock carts delivering cane. As the feeding of the mills is done entirely by hand a great deal of labour could be avoided by the use of suitable derricks for handling the cane, and at the same time give a more regular feed to the mills. The methods of clarification appeared to be capable of considerable improvement, many of the appliances being defective or badly situated for inspection and cleaning. In most of the factories the evaporators and vacuum pans were adequate, but in only two were the crystallisers sufficient in number to ensure the maximum reduction of the sucrose in the molasses. Since the quality of sugar depends to a great extent upon clarification, the inefficiency of this section of the plants is responsible for the inferiority of the average product. One small factory, however, possessing an adequate clarifying and crystallising plant, was producing two sugars of excellent quality. Although the Indian factories do not at present obtain a satisfactory extraction, a few modifications and additions would enable them to obtain results very little behind those of the best works in Java.

THE Carnegie Institution of Washington has just published Prof. E. C. Case's fifth contribution to our knowledge of the vertebrate fauna of the Permo-Carboniferous red beds of North America (Publication No. 207). More than half of the work is an exhaustive technical description of the geological formations themselves in all known regions, with numerous quotations from the writings of other authors. The second part is more general, and includes a valuable summary of the results of Prof. Case's own researches. The vertebrate fauna is one of estuaries, swamps, alluvial plains, and open woodlands. Among the fishes, even the sharks have a fresh-water appearance.

All the amphibians are of the usual Labyrinthodont pattern, with a carnivorous dentition. Among the reptiles the teeth are more varied, but hitherto no form has been discovered which can be regarded as purely or even largely herbivorous. Some species must have been powerful carnivores, others may have eaten plants mingled with a main diet of hard-shelled molluscs. In outward shape, according to Prof. Case's numerous restorations, there is monotonous sameness, both among amphibians and reptiles—animals with large head, short neck, ungainly trunk, and weak limbs. The only notable feature is the well-known dorsal crest of Dimetrodon and its allies, produced by the elongation of the neural spines of the backbone. During life, of course, more variety may have been imparted to the different forms by coloration and epidermal structures. Prof. Case concludes that although the earliest of the North American Permo-Carboniferous reptiles are closely related to those found in South Africa, the evolution of the group was different in the two regions. In North America all specialisations seem to have been in the direction of higher reptiles, while in South Africa specialisation was clearly in the direction of mammalia.

THE fifty-third annual report of the Government cinchona plantations and factory in Bengal for the year 1914–15 is a remarkably interesting document, and affords striking evidence of the valuable work unobtrusively carried on by the distinguished botanists who have held the post of superintendent of cinchona cultivation in Bengal. Between 1887 and 1892 enough bark was produced in the plantation at Mungpoo to meet the annual demand, never exceeding 4000 lb., for quinine. By 1905 the demand had risen to 15,000 lb., but the annual yield from plantation bark never reached 9000 lb. of quinine. A new plantation was started at Munsong, the old one improved, the factories enlarged, and a quinologist appointed, with the result that now the annual output of quinine has increased to as much as 50,000 lb. Not only has the quality of the trees planted been greatly improved and the area under cultivation enlarged, but the methods of extraction now employed have raised the average quinine percentage from 2·5 to 4·5. Since 1905 the annual possible harvest has increased from about 300,000 lb. of 2·5 per cent. bark to 1,000,000 lb. of 4·5 per cent. bark, a quantity assured for many years to come; the possible annual output of the factory has increased from 14,000 lb. to more than 50,000 lb. of quinine, its extraction efficiency has been raised from not more than 75 per cent. to 95 per cent. of the possible, while the manufacturing cost of quinine has been reduced from Rs. 9 to a little more than Rs. 5 per lb. Moreover, the quinine reserve has risen from less than 3500 lb. to more than 163,000 lb. When it is remembered that cinchona takes ten years to arrive at maturity, this record of ten years' work must be regarded as a remarkable achievement. The work of reconstruction initiated by Sir David Prain has been most ably carried on by Major Gage, his successor in office, who records his indebtedness to Mr. Shaw, the Government quinologist, and to the managers of the two plantations, Mr. H. F. Green and Mr. P. T. Russell, through whose keen interest and cordial co-operation the success of the undertaking has been rendered possible.

IT has long been suspected that the mutarotation phenomena observed in freshly-prepared solutions of many sugars might be due, not to a direct isomeric change, but to changes involving the formation of one or more intermediate products. Direct evidence in favour of this view is given in a paper by Prof. Irvine and Miss Steele on "The Mechanism of Mutarotation in Aqueous Solution," which appears in the August issue of the Chemical Society's Journal. The curves showing the changes of conductivity and of rotatory power in freshly-prepared aqueous solutions of tetramethylglucose are of the usual simple form; but when the sugar is dissolved in aqueous boric acid the conductivity passes through a maximum at the end of about two hours, whilst the rotatory power shows a well-marked arrest at about the same time. These observations indicate the formation of an intermediate product capable of combining with boric acid. The authors consider that this product is an oxonium hydrate. The conductivity curve gives some indication, however, that the limit of complexity has not yet been reached, and that there may be two intermediate products instead of only one.

Engineering for September 17 has a concluding article on worm-gear in which is contained the discussion on an important paper by Mr. F. W. Lanchester, reprinted in previous articles. The Lanchester worm is of the hollow type, and very careful tests reveal very high and consistent efficiencies. The preservation of the oil film between the surfaces in contact is all-important, and it is possible that the film can be kept better in place with a hollow worm than a parallel one. Mr. Lanchester says that for the purposes of discussion the surfaces in contact in his worm-gear may be represented by ellipses of elongated form. The motion is broadside, and the pressure is continually exerted on a region to which the oil had just previously been squeezed, so that the surface continually floated on an oil film instead of sinking through it. With light pressures this action is not important, but when the pressures exceeded half-ton to one ton per square inch the squeezer action became important. The gear was applied to the Lanchester car in 1897, and had been fitted to every Lanchester car since that date.

THE Manchester Literary and Philosophical Society has published a catalogue of the serial publications in its library. The catalogue has been compiled under the direction of the honorary librarian, Mr. C. L. Barnes, by the librarian, Mr. A. P. Hunt. The total number of current publications at present received by the society is 810; and these, together with a number of serials no longer in progress, have all been dealt with. To facilitate the finding of any individual work, a copious index has been added, in which each town, institution, and title of publication is mentioned separately.

OUR ASTRONOMICAL COLUMN.

THE SUPPOSED NEW COMET.—Ephemeris Circular No. 492 of the *Astronomische Nachrichten* contains a notice from Prof H. Kobold, Kiel, announcing that Prof. Frost has identified the supposed new comet discovered by Mr. J. E. Mellish on September 6 with N.G.C. 2261.

STAR COLOURS.—There are two methods by which the colours of stars are being determined:—(1) the direct method, in which a coarse objective grating is used, and estimates made of the mean effective wave-lengths of the light from the stars; and (2) comparison of the relative intensities of two separate regions of the stellar spectrum. As usually effected, this is an indirect method, based on measures of photographic and visual (or photovisual) magnitudes. Three recent contributions from Mount Wilson Observatory, (*Astrophysical Journal*, vol. xli., No. 1) deal with this subject. In one of these Prof. E. Hertzsprung presents an account of his researches on the stars in the cluster N.G.C. 1647 by the grating method used in conjunction with the 60-in. reflector of the Mount Wilson Observatory. Photometric magnitudes and effective wave-lengths are given for rather more than 200 stars in the cluster. In the case of 44 stars, a comparison of the measures of effective wave-length are compared with a rough classification of the spectrum. Partly from this paper, Mr. F. H. Seares derives data for a comparative study of colour-indices measured indirectly with those obtained by transforming effective wave-lengths. Results for 47 stars of magnitudes between 11·5 and 15 indicate that for this interval the two series of colour-indices show the same increase in mean colour with increasing magnitude. In the remaining paper, Prof. Hertzsprung discusses the mean effective wave-length of a number of absolutely faint stars. Effective wave-lengths show little change for stars of abs. mag. +3 and +8, the values lying between λλ 4500–4600. The suggestion is made that the abs. mag. +3, corresponding to a temperature of 3400° abs. for a black body the size of the sun, represents the stage of a cooling star at which relatively dark solid matter begins to form on its surface.

RAIES ULTIMES.—Comte A. de Gramont designates by this term those lines in the spectrum of an element which for any given source of luminescence persist longest as the percentage of the element is reduced. They are thus lines of maximum sensitivity. In a paper lately published (*Ann. Chem.*, vol. iii., May-June, 1915) it is pointed out that the effect of reduction of quantity of substance should not be confounded with diminished exposure in photographing the spectrum. The one operates on the spectrum, the other acts merely on the record. The persistent lines are not identical in the two cases. It appears that in general the vestigial spectrum is not of necessity made up of remnants of the strongest lines of the elements, though, in fact, the *raies ultimes* mostly seem to be either the strongest or among the strongest lines, and they are usually lines which readily reverse. They bear some sort of relationship to the "long" lines employed by Sir Norman Lockyer some forty years ago as criteria to establish the presence of less spectroscopically conspicuous elements in the sun. The paper contains interesting suggestions regarding the energy distribution in line spectra and on the relationship between the *raies ultimes* and the point of maximum radiation.

EARLY NAUTICAL ASTRONOMY.—An address on the beginnings of geographical science, delivered by Sir Clements R. Markham before the Royal Geographical Society on June 10 last (*Geographical Journal*, vol. xlvi., No. 3, September, 1915), contains much extremely interesting information regarding the development of astronomical methods, instruments and tables, employed in navigation during the period of revival of nautical adventure; the period of the first Transatlantic voyage, and the rounding of the Cape of Good Hope. It was, in fact, the efforts of the Portuguese to open up the western coast of Africa, leading seamen into southern waters out of sight of the familiar Polaris, that necessitated the formulation of new methods. A mathematical Junta appointed by King João II. of Portugal (1481–95) triumphed over the difficulties. It now appears that a Jewish royal physician was the leading spirit of the commission, and it was a friend of his, Abraham Zacuto, professor of astronomy at Salamanca, who had ready at hand the requisite tables giving the sun's declination. Lack of space forbids further description here. The lecturer drew largely on the researches of Senhor Joaquim Bensaude, in particular on the latter's work "L'Astronomie nautique au Portugal à l'époque des grandes découvertes," Bern, 1912.

APPROXIMATE DETERMINATION OF PLANETARY LONGITUDE.—In *Knowledge* (August) Prof. Herbert Chatley gives a simplified method of calculating planetary longitudes for elliptic orbits without employing intricate mathematics. The method depends on the assumption, apparently very nearly true, that the difference between uniform circular motion and elliptic is harmonic. It is claimed that the method is capable of giving results to within a few minutes of arc.

THE CANADIAN ARCTIC EXPEDITION.

MR. VILJALMUR STEFANSSON, the Canadian Arctic explorer, whose unexpected safety is announced, contributes his personal narrative of the expedition to Monday's *Daily Chronicle*. He left Alaska in July, 1913, for the Beaufort Sea. Bases were also to be established on Prince Albert Sound and Patrick Island. Mr. Stefansson was accompanied by Dr. Forbes Mackay and Mr. James Murray, of Shackleton's first Antarctic expedition; M. Henri Beuchat, a French anthropologist, who was to study the Eskimo of Bank Land; Mr. W. L. McKinlay and others. Captain Bartlett, of Peary's North Pole expedition, was in charge of the *Karluk*, the main ship of the expedition. Whether or not the *Karluk* could reach Patrick Island and penetrate the Beaufort Sea depended on the prevailing winds. With a persistence of easterlies, which Stefansson hoped for, this would be possible, but otherwise he realised that his plans must be modified.

Early in August, 1913, the *Karluk* was beset in the ice in 147° W., fifteen miles off the shore. In the belief that the ship was firmly frozen in, Stefansson, with three companions, went ashore to hunt towards the end of September. During their absence a strong north-easterly gale broke up the ice and carried the ship away to the west. Passing near the coast firmly beset in the ice the *Karluk* was carried north-westward to 73° N. 162° W. on November 11. Her drift then changed to south-west, and by the end of the year she was sixty miles north-east of Herald Island. Two weeks later the ship was crushed and sank, but not before a quantity of stores had been placed on the ice. Herald Island could not be approached on account of open water, so tracks were made successfully for Wrangell Island. A party of eight, however, including Dr. Mackay, Mr. Murray, and M. Beuchat, who had left the *Karluk* earlier in an attempt to reach

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Herald Island, failed to turn up. Captain Bartlett crossed Long Sound and with great difficulty reached the Alaskan coast, which he followed eastward to Emma Harbour, whence a whaler took him to St. Michael. From there a relief ship set out to Wrangell Island and brought back the remaining survivors of the *Karluk*. Three of the party had died on the island, and later search failed to reveal any trace of Dr. Mackay and his party, all of whom probably perished by falling through the ice.

Meanwhile Stefansson had attempted to retrieve the fortunes of the expedition. After a winter in the Mackenzie delta (1913–14), he set out northward over the ice with seven companions, starting from Martin Point, 140° W., on March 22, 1914. Three weeks later the supporting party turned back, bringing news that Stefansson meant to continue northward for at least another fifteen days. A small vessel, the *Polar Bear*, searched for them along the coast of Banks Land last year, but found no trace, and it was generally supposed that Stefansson and his party had perished until the news came last week. Travelling over the ice, and often drifting with it, the party reached 73° N., 140° W. Stefansson then decided to turn eastward, and ninety days after leaving Cape Martin landed on Banks Island, thirty miles south of Cape Alfred. From there he went south to Cape Kellat and met his supply ship. In the winter a four-hundred mile sledge journey to Victoria Island failed to reveal Eskimo. In February this year Stefansson, with three companions, set out northward *viâ* Cape Alfred to Patrick Island, and up its eastern side to Cape McClintock. To the north-east they discovered an extensive new land rising to a height of 2000 ft. The return journey was along the west coast of Melville Island, across McClure Strait, to the Bay of Mercy, and thence across Banks Island to Cape Kellat. From there Stefansson reached Herschell Island in the *Polar Bear*. Throughout his travels he lived chiefly on caribou, bears and seals, and suffered no want. He has since returned to Banks Island, and next year intends to explore his new land, and to make a journey over the Beaufort Sea. Surveys were made of the lands visited, and the work of Sir Robert McClure amplified and extended. R. N. R. B.

THE STANDARDS AND FUNCTIONS OF MUSEUMS.

OUR forefathers regarded museums simply as storehouses for freakish, reminiscent, or merely curious objects, and as the place in which to deposit the various oddments presented by travellers abroad. There was no "purpose" in the display of the objects exhibited, other than that of perchance amusing stray visitors. So far as this country is concerned, the new era of museum management began with the foundation of the British Museum at Bloomsbury, when the first attempt was made to eliminate the purely "showman" element and substitute meaning and purpose in the arrangement of its contents. As compared with the Continental museums, it stands easily first in the character of its endeavours to interest, as well as instruct, the public. But in this we have serious rivals in the museums of the United States, as may be gathered from the forty-sixth annual report of the American Museum of Natural History. In this, and other similar institutions in America, huge sums are spent on large groups of mammals and birds mounted to reproduce the exact environment in which such animals lived. And this illusion is further heightened by skilfully painted backgrounds, executed by artists who accompany the collectors in order that they may reproduce the actual environment in which the specimens lived. This, however, is but an extension of the methods of exhibition introduced by the British Museum many years ago.

In exhibitions designed primarily to instruct rather than to amuse, it is an open question whether our rivals are not over-reaching their ideals—at any rate, in so far as the work of a natural history museum is concerned. Mineralogy, for example, no doubt must find a place here, but large models of a copper mine, such as that reproduced here, and the method of raising ore, would seem to have a more appropriate place in a museum of technology.

The students' collections of such museums must either be of insignificant proportions, or the staff must be much larger than that attached to museums in Great Britain, otherwise the curatorial work in connection therewith would make it impossible for the staff to devote so large a portion of their time to work which is done, indifferently well, it is true, in this country, under the auspices of the Board of Education, as "Nature-study." That this should be so is unfortunate, for, as a means of awakening the intelligence and powers of observation, there is no more efficient aid than the study of natural history, using this term in its widest sense.

Copper Queen Mine Model, Department of Geology and Invertebrate Palæontology. The American Museum of Natural History.

In addition to lectures to children and teachers, special rooms are set apart in American museums for children's collections, while this work is supplemented by travelling museums sent round from school to school by means of motor-vans. Something of this kind could well be imitated in this country.

The department of public health in the American Museum of Natural History answers to no more than one aspect of the department of economic zoology of the British Museum of Natural History—that which concerns the organisms injurious to man—for no attempt seems to have been made to bring together a collection of domesticated animals. On the other hand, our rivals are ahead of us in having instituted

an exhibition of living bacteria such as more or less affect the well-being of the human race.

It is to be hoped that this report will be widely read in this country by all who are concerned with the management of museums, for it is full of most valuable information, and it is becoming increasingly clear that the museum is becoming more and more a factor in the well-being of the community. W. P. P.

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THE BRITISH ASSOCIATION.

SECTION C.

GEOLOGY.

OPENING ADDRESS[1] BY PROF. GRENVILLE A. J. COLE, F.G.S., M.R.I.A., PRESIDENT OF THE SECTION.

THE geologist has long been accustomed to regard the crust beneath his feet as subject to changes which are immeasurably slow in comparison with the duration of his personal life. James Hutton has sometimes been charged with catastrophic tendencies, in requiring a complete wearing away of the continents, followed by a somewhat sudden restoration of the land-surface. But he was careful to urge[2] that "the powers of nature are not to be employed in order to destroy the very object of those powers; we are not to make nature act in violation to that order which we actually observe." He remarks[3] that "this world is thus destroyed in one part, but it is renewed in another; and the operations by which this world is thus constantly renewed are as evident to the scientific eye as are those in which it is necessarily destroyed." Yet the operations that are to "give birth to future continents," as well as those that wear down a continent to the level of the sea, are not the result of "any violent exertion of power, such as is required in order to produce a great event in little time; in nature, we find no deficiency in respect of time, nor any limitation with regard to power." Far from believing in the complete loss of the former land-surface before upheaval raised the new, Hutton points out that "the just view is this, that when the former land of the globe had been complete, so as to begin to waste and be impaired by the encroachment of the sea, the present land began to appear above the surface of the ocean. In this manner we suppose a due proportion to be always preserved of land and water upon the surface of the globe, for the purpose of a habitable world, such as this which we possess."

[1] Abridged by the author.

Changes in the Relative Proportions of Sea and Land.

Few geologists, however, will now urge with Hutton that a "due proportion" has always been preserved between land and water on the surface of the globe, if by those words is meant a proportion such as we now enjoy. If we go back to early times, we must consider, with R. A. Daly,[4] the possible grouping of the land against which the Huronian or late pre-Cambrian sediments were formed. Daly has imagined, as one of the causes contributing to a "limeless ocean," a primitive distribution of land and water very different from that which determines our continental land to-day. His pre-Huronian land-surface is pictured as merely a number of large islands, on which no long and conspicuous rivers could arise.

It may be said that this primitive condition of the distribution of land and water is very unlikely to return. But we have evidence that Hutton's "due proportion" has been interfered with from time to time. The very general spread of the sea over the land-margins in Cenomanian times is attributable to a shallowing of the ocean-floors, and it is difficult to say whether this process has been rhythmic or exceptional in the history of the globe. The Carboniferous period opened with marine conditions over a large part of the northern hemisphere, indicating, not only a continuation of the Devonian seas, but an overflowing of much of the Caledonian land. The same period closes with an extension of the continental edges, and the formation of swampy flats, in which the vegetation of the epoch has been abundantly preserved. Similarly, the sea which deposited the Cretaceous strata, after encroaching alike on South Africa and Scandinavia, withdrew to a considerable extent in Eocene times.

The Foundations of the Earth's Crust.

Hutton remains at present unassailable in one of his most remarkable propositions. For him, the oldest rocks that we know are sedimentary, and these sediments differed in no respect from those of modern days. This conclusion has perhaps not received the full attention it deserves. It now appears

[2] "Theory of the Earth" (1795), vol. ii., p. 547.

[3] *Ibid.*, p. 562.

[4] "The Limeless Ocean of Pre-Cambrian Time," *Amer. Journ. Sci.*, vol. xxiii. (1907), p. 113; and more fully in "First Calcareous Fossils," *Bull. Geol. Soc. America*, vol. xx. (1909), p. 157.

certain that we possess no record of a sedimentary type peculiar to the early stages in the formation of a habitable crust. If such a type existed, it has been lost to us through subsequent metamorphism, amounting to the actual fusion and redistribution of its constituents. The Grenville Series of North America rests on a floor of granitoid rock, which is intrusive in it, and which belongs to the oldest of various irruptive groups. The Grenville Series includes conglomerates, false-bedded quartzites, and a development of limestone that is altogether exceptional for pre-Cambrian times. In Finland,[5] sediments have been traced down to the layer where their original characters vanish in a general "migmatitic" ground. Conglomerates and phyllites occur among them, and near Tampere (Tammerfors) the seasonal stratification is as well recorded in a Bottnian shale as it is in the Pleistocene clays made famous in Sweden by De Geer. Vein-gneiss (Adergneis) underlies these ancient systems, and represents their destruction by the injection of granite from below. If we accept the hypothesis of Chamberlin, Hutton's position becomes strengthened by the postulation of an unfused planetesimal crust, and the restriction of molten masses and hydrothermal activity to the interior of a consolidating globe.

So far as we have any record left to us, Hutton remains fundamentally in the right. All modern research shows that the schists and gneisses can be explained by causes now in action. The vast majority of schists were at one time normal sediments; others were tuffs or lavas; but, whether originally sedimentary or igneous, they owe their present characters to widely spread regional metamorphism.

The Undermining and Weakening of the Foundations of the Crust.

Is there, then, any reason to depart from Hutton's position as to the recurring cycle of events in the history of continental land? I think it must be admitted that the isostatic balance was far more frequently disturbed in what we may call Lower pre-Cambrian times than it has been in more recent periods. Local fusion must be regarded as an important cause of crustal weakening. If we wish to study the nature of the process, it is reasonable to examine regions that have at one time lain deep within the crust. Such regions are provided by the broad surfaces of Archæan rocks that were worn down through continental decay before they sank beneath the Cambrian sea.

It is well recognised that an ancient continent at one time stretched across the northern hemisphere. Wherever later deposits have been stripped from its surface, from central Canada to the Urals, and probably far beyond, we find that the older materials of this undulating continental platform consist largely of intrusive igneous rocks. These, moreover, have frequently a gneissic structure. Again and again, strongly banded gneisses occur, in which granitic material, verging on aplite, alternates with sheets of hornblendic or biotitic schist. The biotitic varieties can often be traced back into amphibolites. In places, lumps of these amphibolites are seen, streaked out at their margins, and providing a clear explanation of the dark bands throughout the gneiss.[6]

[5] J. J. Sederholm, "Ueber eine archäische Sedimentformation im südwestlichen-Finland," *Bull Comm. géol. Finlande*, No. 6 (1899), p. 215.

[6] Since the historic works of A. C. Lawson (for example, "Report on Rainy Lake Region," *Geol. Surv. Canada*, Ann. Report for 1887, plates v. and vi.), these features have been traced in many areas. Compare W. H. Collins, "Country between Lake Nipigon and Clay Lake, Ontario," *Geol. Surv. Canada*, Publication 1050 (1909), p. 52; A. L. Hall, Presidential Address on the Bushveld Complex, *Proc. Geol. Soc., S. Africa*, 1914, xxii; P. A. Wagner on Rhodesian gneisses, *Trans. ibid.*, vol. xvii., 39; and works cited in the next reference.

This swallowing up of a mantle of basic material by a very different and highly siliceous magma rising from below is, indeed, seen to be a world-wide feature, wherever we find the lower crust-layers brought up within reach of observation. The tuffs and lavas of the Keewatin series have supplied the dark material in Canada, and similar rocks have been worked up into the gneisses of Galway, Stockholm, and Helsinki. The frequency of amphibolite in these ancient composite rocks is explained by the fact that this type of rock is the final term of various metamorphic series. While many lumps, for instance, in the gneisses of Donegal are residues of Dalriadian dolerites (epidiorites), others, rich in garnet and green pyroxene, and often containing quartz, are derived from a mixture of sediments in which limestone has been prevalent.[7] During the absorption and disappearance of these masses in the invading granite magma, the amphibole acquires potassium and breaks down into biotite, and biotite-gneisses result, which may extend over hundreds of square miles.

The details of such an igneous invasion are worthy of careful study, since only in this way can we follow out the progress of subcrustal fusion. We see the highly metamorphosed material further attacked by the great cauldrons under it, and becoming seamed with intersecting veins. Block after block has been caught, as it were, in the act of foundering into the depths. In the gradual absorption of these blocks, and their penetration by insidious streaks of granite, we see pictured on a few square yards of surface the destruction of a continental floor.

The invasion of a "hard and brittle"[8] crust by an attacking magma was finely described by Lawson in 1888. Lawson pointed out that the Laurentian gneisses gave no evidence of having "yielded to pressures and earth-stresses." The folding of the overlying series was prior to the solidification of the gneisses, and occurred[9] "while the latter were yet in the form of probably a thick, viscid magma upon which floated the slowly shrinking and crumpling strata of the Coutchiching and Keewatin series. . . . Large portions of these rocks have very probably been absorbed by fusion with the magma, for the Laurentian rocks appear to have resulted from the fusion not simply of the floor upon which the Coutchiching and Keewatin rock first rested, whatever such floor may have been, but, also, with it, of portions of those series."

The conversion of the lowest Archæan series, the Coutchiching sediments, into crystalline schists is attributed to thermal metamorphism, and to hot vapours streaming from the molten floor. Lawson realised the importance of shattering in allowing a magma to advance into an overlying "brittle" series, and he is, so far as I know, the first observer to develop in satisfying detail what is now known as the stoping theory of igneous intrusion.

James Hutton always had in mind the effect of heat in "softening" lower layers of the crust. His consolidation of strata by heat is preceded by a stage of melting. Sederholm,[10] while referring back to Hutton as the pioneer, shows how in the vein-gneiss

[7] See Michel Lévy, "Granite de Flamanville," *Bull. carte géol. France*, vol. v (1893), p. 337; G. A. J. Cole, "Metamorphic Rocks in E. Tyrone and S. Donegal," *Trans R. Irish Acad.*, vol. xxvi. (1900), p. 460; O. Trüstedt, "Die Erzlagerstätten von Pitkäranta," *Bull. Comm. géol. Finlande*, No. 19 (1907), pp. 72 and 92; F. D. Adams and A. E. Barlow, *op. cit.* (1910), pp. 95 and 97; "F. Kretschmer, "Kalksilikatfelse in der Umgebung von Mährisch-Schönberg," *Jahrb. k. k. geol. Reichsanstalt*, vol. lviii. (1908), p. 568; etc.

[8] A. C. Lawson, *op. cit.*, p. 140. See also his revision of the area, *Geol. Surv. Canada*, Memoir 40 (1913).

[9] *Op. cit.* on Rainy Lake, p. 131.

[10] "Ueber eine archäische Sedimentformation im südwestlichen Finland," *Bull. Comm. géol. Finlande*, No. 6 (1899), p. 133; and "Ueber ptygmatische Faltungen," *Neues Jahrb. für Min.*, Beilage Band 36 (1913), p. 491.

stage the unmelted sediments exhibit plasticity and become intensely contorted. The softening, in fact, induces flow. There is here no crushing or mylonitisation, but rather a viscid running of constituents, some on the verge of fusion, some, I venture to think, actually fused. Such rapidly repeated and intricate folding is most intense when *lit par lit* injection has set in, and when the whole composite mass has become weak and plastic. The presence of confined water in aiding this plasticity must on no account be overlooked.

It may be well to illustrate this contention by one or two concrete instances from districts not remote from us at the present time. The noble cliffs of Minaun in Achill Island have been worn by the Atlantic from a mass of evenly-bedded quartzites of Dalriadian age. These are invaded by veins of a very coarse red granite, the main mass of which lies below the present sea-level.[11] The edges of the strata appear fairly horizontal on the cliff-face; but contortion sets in towards the base, and the hard resisting rock has here[12] "undergone intense crumpling and overfolding, such as one meets with on a large scale in mountain ranges, and this contorted flow seems entirely due to the yielding that has taken place in the region of heating." The large size of the constituent crystals of the granite indicates that the surrounding rock was still maintained at a high temperature.

South of Foxford, again, in the county of Mayo, the granite of Slieve Gamph invades a series of mica-schists and quartzites. The margin is cut, as usual, by veins that filled the cracks both of the main granite and the metamorphosed sediments. These sediments have become, prior to the shattering, crumpled and overfolded along the contact-region, and the section upon the glaciated slope resembles that of a fluidal rhyolite on a highly magnified scale.

The wonderful contortion of the composite mass that forms the north end of the Ox Mountains (Slieve Gamph) in the county of Leitrim gives a similar impression of viscid flow. The melting of a single constituent of the invaded schists, which here include amphibolites, would enable them to yield in response to the pressures that were forcing the granite magma in thin sheets between them. Their metamorphism is thermal, and the forces that have produced the crumplings are not those of shearing acting on a solid mass, but may have operated from a distance hydrostatically through the magma.

Again, where limestones occur near granite contacts amid a series of various sedimentary types, they display folded structures in an altogether exceptional degree. Silicates have developed along their bedding-planes, but these have become contorted and rolled upon one another as metamorphism reached its maximum stage. At Maam Cross and Oughterard, in the county of Galway, along the margin of the great granite mass that stretches thence southward to the sea, these flow-structures are conspicuous on weathered surfaces.

The main object of the foregoing discussion is to point out that the Huttonian cycle, in which thermal changes play so large a part, implies a serious weakening of the crust as magmas advance into it from below. The extensive metamorphism of the pre-Cambrian strata, which amounts to a distinctive feature, must, I think, be attributed, not to special intensity of tangential pressures in early times, but to frequency of igneous attack. Much of the crumpling of our schists may result from Hutton's "softening," the pressure being supplied from superincumbent masses, or even hydrostatically, and the flow occurring laterally, or vertically downwards, towards regions where destruction by absorption was going on. The features seen during the falling in of the walls of the lava-lake of Kilauea in Hawaii afford some idea of what takes place in zones of melting within the crust.

Under such conditions in early pre-Cambrian times, even the surface-rocks must have fallen in at some points and have been replaced by igneous extrusions. Isostatic adjustments must have been very frequently disturbed. Folding of rocks, as a phenomenon of lateral surge and flow, must have made itself freely felt at the earth's surface. It is safe to assert that such conditions have not been repeated on a broad scale at any geological period subsequent to the spread of the Olenellus-fauna. Geochemical evolution, however, may have surprises still in store, and, in spite of long tradition, we are disinclined nowadays to rely too strongly on arguments based upon the sanctity of human life.

Possible Breaks in the Slow Continuity of Earth-movement.

1. *The Mountain-building Stage.*

Even with the thickened sedimentary crust beneath us, and the confidence inspired by our limited experience of the earth, we may ask if subterranean changes may not still result in catastrophes at the surface.

What, in fact, is likely to occur if a mountain-building episode again sets in? Such episodes, affecting very wide areas, have undoubtedly recurred in the earth's history. We do not know if they are rhythmic; we do not know if they represent a pulsation, decreasing in intensity, inherited from the stars and hampered by increasing friction; we do not know if they record internal chemical changes, which have no climax, because they are neither cyclic nor involutionary, but evolutionary. The mid-Huronian chains, now worn down and supplying such valuable horizontal sections, were evidently of great extent; but we cannot say that they were vaster than those of later times.

The phenomena accompanying the growth of a single chain in the Cainozoic era give us, at any rate, ample food for thought. Though the narrow cross-section of the core of such a chain limits our field of observation, the same inpressings of igneous material, and the same features of rock-weakening and rock-destruction, may be observed as in the immense basal sections exposed in the Archæan platforms. The progress of geological time has not diminished the activity in the depths. The granodiorite of western Montana,[13] for instance, which intruded during an uplift in early Eocene times, has attacked the Algonkian sediments of the district, producing phenomena of stoping and assimilation in the true "Laurentian" style.

In the western and central Alps, again, the absence of any fossiliferous strata older than the Carboniferous arouses some surprise, until we find that many of the granitic intrusions are of late Carboniferous age. The crystalline schists west of Časlav in Bohemia and in the Eisengebirge are now attributed by Hinterlechner and von John[14] to the metamorphism of Ordovician strata by younger granite, which intruded in post-Devonian and probably in Carboniferous times. Much of the gneiss and granite of the Black Forest and the Vosges is now, moreover, removed from the Archæan, and is shown to be associated with the Armorican movements.[15] These vast intrusive

[11] *Proc. Geol. Assoc.*, vol. xxiv. (1913). Plate 17.

[12] G. A. J. Cole, "Illustrations of Composite Gneisses and Amphibolites in N. W. Ireland," *C. R. Congrès géol. internat.*, Canada (1913), p. 312.

[13] J. Barrell, "Marysville district, Montana: a study of igneous intrusion and contact metamorphism." *U.S. Geol. Survey*, Prof. Paper 57 (1907), and W. H. Emmons and F. C. Calkins, "Phillipsburg Quadrangle," *ibid.*, Paper 78 (1913).

[14] *Verhandl. k. k. Reichsanstalt*, 1910, p. 337, and *Jahrb.*, *ibid.*, vol. lix. (1909), p. 127.

[15] P. Kessler, "Die Entstehung von Schwarzwald und Vogesen," *Jahresberichte Oberrhein. geol. Vereines*, vol. iv. (1914), p. 31.

masses occupy the place of strata of pre-Permian age. The great development of thermal metamorphism in the Erzgebirge and in Saxony,[16] two classic regions of the dynamometamorphic school, is now widely recognised, and this activity is also assigned to late Carboniferous times. The work of C. Barrois in Brittany is concerned with absorption-phenomena resulting from intrusions during the same mountain-building epoch.

Sederholm[17] has suggested that the ground above an area affected by processes of mountain-building cracks and becomes faulted, while the more plastic zone below flows under pressure into folds. But the blocks of the "brittle" layer, as Lawson has it, may be seriously displaced by movements in the zone of folding, and subsidences of a regional character may occur. The pressure that has driven an excess of matter to the region of overfolding has squeezed it from beneath an adjacent region. Crumpling and overfolding are accompanied by a shearing away of the matter in one zone from that of another which overlies it; this must result in considerable disturbance of the zone nearer the surface.

We usually regard such disturbances from the uniformitarian point of view. May not, however, actual mountain-building be the break in a slow process of "softening," to use Hutton's term? For a long time the isostatic balance suffers only small disturbances, restoring itself automatically on a gently yielding underworld. Then something gives way; something—a large mass of supporting rock—suffers a change of state. The balance is destroyed abruptly, and mountain-building and rapid subsidences have their day. O. Ampferer,[18] with his customary largeness of view, has referred superficial evidences of disturbance, such as mountain-ranges, to dragging movements of a mobile *Untergrund*. He urges that physical and chemical changes within the earth may produce considerable local changes of volume. Vertical movements lead to upfolding, and this leads to gravitational sliding. The zone of folding that we have been considering as normal near the *Untergrund* thus becomes transferred to the surface of the earth.

I am not now concerned with the causes of folding, beyond the fact that at a certain critical stage the material involved may move at a rapid rate. Changes of state, physical and chemical, occur with some abruptness. In the case of rocks, the softening or melting of even one constituent may allow of flow, and, as we have observed, this flow in a lower layer may soon become manifested in surface-changes.

Ampferer and Hammer[19] have recently considered the overfolded structure of mountains as due to a considerable local reduction in volume of the *Untergrund*. The upper crust presses inwards from opposite sides, and the parts that are thrust downwards become absorbed and carried away with the retreating region of the *Untergrund*. The surviving parts fall over on either side, producing, as the whole continues to close in, folds that are not so very different from the now familiar *nappes de recouvrement* which these authors hesitate to accept. The important point for our present purpose is the restatement of the results of gravitation on the flanks of an uprising chain.

The surprising thing about our folded mountain-chains is the way in which they have been eroded parallel to the strike of the overthrust sheets or overfolds. Apart from occasional detached "klips," the distal parts of these masses must have been at one time continuous with those proximal to the root-region. The forward movement could not have occurred if denudation had negatived the effects of folding on the surface.

The marine or lacustrine deposits of the age immediately preceding that of uplift obviously cannot be consolidated at the epoch of upheaval. Gotlandian sands and muds must have overlain the heaving masses that rose as Caledonian land. The swamps of the Coal Measures were contorted in the Armorican chains: the highest beds of these must have been as yielding and as capable of flow as the Flysch that overlay the growing Alps. In all these cases, familiar to us in Europe, the covering masses must have responded to the crumpling under them, and, when reared to dangerous eminences, rapidly became a prey to denudation and gravitational downsliding. They can scarcely be regarded as protective, and their removal would leave the brittle masses below more liable to fracture and to the "calving" process that forms klips.

In some cases separation seems to have taken place as the moving mass fell forward. The klips of hard material embedded in softer strata are thus a kind of rock-spray, hurled in advance of the breaking earth-wave.

Termier[20] in no wise fears to speak of the progress of a "traîneur écraseur" during mountain-building as "soudain et rapide comme une rupture d'equilibre, le dernier acte, longuement péparé, mais joué d'*emportement*, de ce drame grandiose."

Rupture combined with rapid movement of the rocks need not be the last act of the drama; but, the more we examine the history of folded chains, the more probable it appears as a culminating episode. The original cover of our present ranges has been lost by denudation. Earth-sculpture in these regions of high altitude and vehement attack has removed much of the evidence that we seek. What remains, however, may lead us to feel that no part of the world in historic times has experienced a mountain-building episode.

Such relatively catastrophic stages have, indeed, not been common in the long history of the earth since pre-Cambrian times. It appears that now and again the "orogenic collapse" of some considerable area disturbs the balance in the crust and spreads far through the upper layers like a disease. Or it may be that the thermal cause of the collapse is common to the whole earth at the same time, and becomes manifest in responsive regions far apart. In any case, the weak places give way and the more resisting ones close in. A readjustment is effected, which then endures through long geological time.

The imminent menace of crustal changes was brought home to us during the terrible period from April 4, 1905, to January 14, 1907, the final twelve months being marked by a veritable earth-storm. Geologically speaking, however, we are near enough to the Tortonian epoch to look forward with some confidence to a quiescent phase. But some day, in its due season, the earth will once more be active. When that time comes, no ingenuity of man will suffice to meet it. Earthquake after earthquake, increasing in intensity, will probably have driven the population to a distance from the threatened zone. Concentration of the folding along a particular earth-line will limit the region of absolute destruction; but the undulations spreading from it, in response to the heavings of the chain, will offer sufficient chances of catastrophe. In the case of our youngest mountain-ranges, these undulations remain perpetuated as domes

[16] C. Gäbert, *Zeitschr. deutsch. geol. Gesell.*, vol. lix. (1907), p. 308; R. Lepsius, "Geologie von Deutschland" (1910), pt. 2, pp. 107 and 172.

[17] *Op. cit.*, *Bull. Comm. geol. Finlande*, No. 37, p. 66.

[18] "Das Bewegungsbild der Faltengebirgen," *Jahrb. k. k. geol. Reichsanstalt*, vol. lvi. (1906), p. 607.

[19] O. Ampferer and W. Hammer, "Geologischer Querschnitt durch die Ostalpen," *Jahrb. k. k. Reichsanstalt*, vol. lxi. (1911), p. 700.

[20] "Les Problèmes de la Géologie tectonique dans le Méditerranée occidentale," *Revue générale des Sciences*, March 30, 1911.

and dimplings of the crust, which are already worn down or infilled respectively by denudation and deposition. Their present forms and places record the last movements of the earth-storm, just as a buckled tramway-rail records the passage of an earthquake. How shall we gauge to-day the intensity of their rise and fall?

In the case of the city devastated by an earthquake, the débris is cleared away, and our descendants in time discover the distorted rails beneath the healing mantle of new grass. Will they realise from this alone the preliminary tremors, the sudden arrival of the culminating vibration, the shock that overcame the elasticity of the crust beneath them, and then the gradual establishment of the conditions under which they have passed their peaceful lives? The crumpled wreckage lies there in evidence before them; but how will they distinguish the work of a few stormy seconds from that due to the gentle earth-creep of a century?

(2) *Regions of Subsidence.*

It was probably E. Suess who brought home to most of us the importance of regions of subsidence in defining the lowlands and the sea-basins from the upstanding masses of the crust. While one region may be folded, another may be broken into blocks; and the two types of movement, that due to tangential thrusting and that due to vertical uplift and down-faulting, may appear in the same region and may alike play their part in producing a lowering of large areas. The domes and dimples that occur beyond the region of acute crumpling may be intensified into fault-blocks by fracture of their boundaries. If catastrophes are possible during uplift, we may look for them also during subsidence.

The cutting-up of mountain-chains by transverse fractures has resulted in the loss of huge blocks beneath the sea. In such cases it is clear that faulting has run a long way ahead of denudation. All trough-valleys, which are often called, somewhat misleadingly, rift-valleys, raise the same questions as to the nature of the steps by which they have been produced. The Rhine Vale, one of the most closely studied examples, dropped 8000 ft. within the limits of Oligocene time. It is improbable that the numerous faults now traceable operated with concerted gentleness.

Abruptness of certain Geographical Changes.—River-capture.

There is a totally different class of terrestrial phenomena which lends itself also to speculation, or to that imaginative faculty, proper to our Section, which enables the geologist to reconstruct. Geographers have taught us to speak lightly of river-diversion and river-capture, and to treat them as frequent occurrences in the history of existing lands. It is interesting to inquire what this process on a large scale may involve.

The draining of the Ragunda lake in Sweden[21] in 1796, by the rapid cutting of a ravine 100 ft. deep in a soft barrier, shows how many of our Glacial lakes, dammed by morainic matter, may have excavated their outlet gorges and run dry in the course of a few hours. The history of the temporary lake behind the Gohna landslip, so brilliantly studied by our vice-president, Sir Thomas Holland,[22] provided a lesson both in hill-destruction and catastrophic flooding. The diversion of the Colorado River, however, in 1905, into the sluice leading to the Salton Sink gives us a definite illustration of river-capture. The "New River" thus produced in the depression to the north-west of Calexico cut a valley 70 ft. deep through the agricultural land that it was meant to serve, and worked the head of this valley backward at the rate of a third of a mile a day.

One of the most remarkable instances of river-diversion in the European record is that of the waters from the north side of the central Alps. At the close of the Pliocene period, the north slopes of the St. Gothard mass and the Bernese Alps, supplying the torrents of the Reuss-Aar-Saane system, drained across the hummocky land near Bâle and sent their waters over to the Doubs. The great Rhine-trough drained southward, and its streams formed tributaries of the Alpine flow near Bâle. The Mainz basin, however, which was infilled by Lower Pliocene alluvium, became tapped by the head of a river that had long run northward from the Hunsrück-Taunus range. This river is the Rhine that we know north of Coblenz, and its alluvium was then spread out where the sea now stretches between Holland and the Yorkshire coast. Its mature valley is still traceable[23] above the present stream-cut in the hills. This river could have no direct influence on the course of the drainage from the Alps. But the bulging of the land at the north end of the Juras still continued. As the text-books remark with some complacency, the Burgundian gate was closed, and the river that had previously crossed westward was diverted northward to the Rhine-trough.

Can we exactly picture what this means? The whole Reuss-Aar-Saane system "on some particular day began to flow northward along the far older tectonic trough, carving away the infilling of detritus, washing back tree-stems that were floating quietly from the Lake of Mainz on their way to the Mediterranean, and finding, when it reached that lake, a notch sufficiently low for its escape across the Hunsrück-Taunus range. An enormous body of water was thus added to that which had formed in Pliocene times a mature valley across these hills."[24] The system indicated above, representing the flow from a hundred miles of snow-clad mountains, must have made a remarkable change in the stream across the Armorican hills. When the Alpine water arrived at the Mainz basin, and found its way into the notch formed by the Pliocene Rhine, it poured down upon the forest-covered delta-land. The changes that have occurred in the unconsolidated ground of Holland in historic times furnish some picture of what must have happened in the prehistoric delta of the Rhine. Land was suddenly built up at some points, islands were carved out at others, and the effects of the catastrophe must have been still manifest when the Scandinavian ice-sheet began to invade the mud-flats from the north.

The capture of a large river may be illustrated by the story of the Vistula. This noble stream represents in a remarkable way the drainage of 190 miles of the Carpathians. All this water becomes concentrated, at the apex of a reversed river-fan, at the east end of the Kielce hills, and it is probable that the upper Vistula was driven to join the San by the advancing ice-front of the Riss age, and that both rivers then escaped southwards. The joint waters were again held up when the Fennoscandian ice rested along the line marked by the Baltic Heights, and it is well known that a great river flowed westward along the stagnating ice-front where now the marshes of the Netze mark its course. As the ice-front shrank backward, towards the Baltic basin,[25] streams flowed down

[21] See especially H. W. Ahlmann, "Ragundasjöns Geomorfologoi," *Sveriges Geol. Undersök*, 1915; also Ahlmann, Carlzon, and Sandegren. "Quaternary History of the Ragunda Region, Jämtland," *Geol. Fören. Förhandl.*, vol. xxxiv. (1912), p. 343.

[22] Records Geol. Surv. India, vol. xxvii. (1894), p. 55, and NATURE, vol. l., p. 501.

[23] W. M. Davis, "Die erklärende Beschreibung der Landformen" (1912), p. 106.

[24] G. A. J. Cole, "The Growth of Europe" (1914), p. 109.

[25] R. Lepsius (*Geologie von Deutschland*, pt. 2, p. 511) urges that the sinking of the floor of northern Europe led to this northward trend of the streams.

over the sands and boulder-clays and cut their valley-heads back southward. Overflows may have taken place on the unconsolidated wall of the great east-and-west river, which was now deprived of its barrier of moraine-filled ice. In one way or another, the shallow valley of the main river was tapped near Kustrin, and the Oder, rising in the Moravian plateau, was sent northward as an independent stream. Similarly, the Vistula was carried off at Fordon, where the bend due to capture is conspicuous at the present day; and the whole drainage of the north wall of the Carpathians swept across the drift deposits down the course of some hitherto unimportant stream. Along the valley thus carved out, brown and yellow cliffs now rise above the marshy flood-plain, and the red castles of advancing Germany have for centuries looked down firmly on the stream. It is quite contrary to our customary philosophy, but a good corrective all the same, to ask ourselves if this lower valley of the Vistula, eighty miles in length, was shaped in a few months or a few years. The main part of the excavation, across unconsolidated lands, may have occupied less time than the building of the strongholds at the fords.

Conclusion.

In spite of the swamping of the Alkmaar country in 1825, in spite of the tragedy of Messina only seven short years ago, we feel that Europe is a settled continent, and we judge the past and future by the present superficial peace. We have applied the same thoughts to human movements, and the inconceivable has happened in our midst. We naturally find it difficult to carry our minds back to epochs when the earth-blocks may have parted asunder as ice parts across the polar seas. We have still, however, very much to learn about causes now in action; and the mystery of the earth, and of our connection with it, grows upon us as we learn. Can we at all realise the greatest change that ever came upon the globe, the moment when living matter appeared upon its surface, perhaps over a few square miles? Matter is either dead or living, that is, endowed with life; there is no intermediate state. And here was living matter, a product of the slime, if you will, but of a slime more glorious than the stars. Was this thing, life, a surface-concentration, a specialisation, of something that had previously permeated all matter, but had remained powerless because it was infinitely diffuse? Here you will perceive that the mere geologist is very much beyond his depth. Let us return to our orderly studies, our patient hammerings, our rock-slices, our chiselling out of fossil shells. Behind it all is the earth itself, quiescent, it may be, but by no means in the sleep of death. As Termier puts it, "La planète n'est pas encore morte; elle ne fait que dormir." If in this address I have dwelt upon the possibility of rapid changes in its surface, no member of our association will feel the least alarm.

Felix qui potuit rerum cognoscere causas,
Atque metus omnes, et inexorabile fatum
Subiecit pedibus, strepitumque Acherontis auari.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS[1] BY MAJOR H. G. LYONS, D.Sc., F.R.S., PRESIDENT OF THE SECTION.

The Importance of Geographical Research.

THIS year, when the British Association is holding its meeting in times of the utmost gravity, the changed conditions which have been brought about by this war must occupy the attention of all the sections to a greater or less extent, and our attention is being called to many fields in which our activities have been less marked or more restricted than they might have been, and where more serious study is to be desired. The same introspection may be usefully exercised in geography, for although that branch of knowledge has undoubtedly advanced in a remarkable degree during the last few decades, we have certainly allowed some parts of the subject to receive inadequate attention as compared with others, and the necessity for more serious study of many of its problems is abundantly evident.

In order that we may see what advance has been made in the scientific study of geography in this country during the last quarter of a century, we must turn to the results that have been attained by the activity of geographical investigators who have devoted themselves to the serious study of various phenomena, and the detailed investigation of particular regions. If we do so I think we must admit that the number of original investigators in scientific geography who are extending its scope in this way is not so large as it might be, nor are we yet utilising sufficiently all the material which is available to us. Anyone who will examine the geographical material which has been published in any period which he may select for review will find that purely descriptive treatment still far outweighs the analytical treatment which alone can lead to definite advances in scientific geography. If pleasing descriptions of this or that locality are sought for, they are for the most part to be found readily in the very large amount of such material that has been and is being published each year by residents, travellers, and explorers; but if information is desired in the prosecution of a piece of geographical research, we are checked by the lack of precise details Few descriptions of this class are sufficiently definite to enable the necessary comparisons to be made between one locality and others which are similarly situated; thoroughly quantitative treatment is for the most part lacking, and while a pleasing picture is drawn which is probably true in character, it is usually inadequately furnished with those definite facts which the geographer requires.

The opportunity to undertake long journeys through distant lands comes to few of us, but this is not the only direction in which research can be profitably undertaken, for there is no part of these islands where a geographer cannot find within his reach some geographical problem which is well worth working out, and which, if well and thoroughly done, will be a valuable contribution to his science. Even for such as cannot undertake such field work the library will provide a host of subjects which have not received nearly the amount of attention and of careful study that they deserve. The one thing essential is that the study should be as thorough as possible, so that all the contributory lines of evidence shall be brought together and compared, and so that the result may prove to be a real addition to geographical science on which other workers may in their turn build.

The ease with which a tract of country or a route can be described by the traveller, and the attractiveness of such a description of a little-known region, results in the provision of a vast quantity of geographical information, the greater part of which has probably been collected by those who have no adequate training in the subject. But anyone who has had occasion to make use of such material in a serious investigation is only too well aware how little precise and definite information he will be able to extract from the greater part of this wealth of material, and in most cases this is due to the traveller's lack of geographical knowledge. He probably does not know the pheno-

[1] Slightly abridged by the author.

mena which should be observed in the type of region which he is traversing, nor can he read the geographical evidence which lies patent to a trained observer at every point of the journey; much, therefore, of what he records may be of interest, but probably lacks data which are essential to the geographer if he is to understand the geographical character of the region, and utilise it properly.

Thus it happens that although the amount of geographical material which is being garnered may be large, the proportion of it which is available for use in a scientific investigation of an area is smaller than is probably realised by those who have not made the experiment. And yet it is only by this scientific investigation of selected localities or of a single phenomenon and by working them out as thoroughly as possible that any real advance in geographical science can be made. There should now be an ever-increasing number of geographers trained to proceed in their investigations by the true scientific method, and there should be a very considerable amount of sound work in various branches of the subject which aims at thoroughly investigating some phenomenon, or group of phenomena, so as to present a grouping of data, carefully verified and critically discussed, in order to arrive at conclusions which may form a useful addition, however small, to the sum of our geographical knowledge.

So far as I am able to judge, the output of serious work of this character is not nearly as large as it should be, and I would indicate some fields in which there is a lack of individual work of this character. Until more of it is undertaken we shall lack in this country the material from which the foundations of scientific geography can be built up, and while our own islands and the various parts of the British Empire furnish unrivalled opportunities for such work, there are still far too many subjects where the most thorough investigations have been made in other countries.

Mathematical geography presents a field for research which has had comparatively little attention paid to it in this country. In many respects this part of the subject is peculiarly suitable for such treatment, since it admits of the employment of precise methods to an extent which is not always practicable in cases where so many of the factors can only be approximately defined. The determination of positions on the earth's surface is carried to great refinement in the national surveys of most civilised countries in order to furnish the necessary controls for the preparation of large-scale maps, but when we pass to the location of travellers' routes, where considerable allowance has to be made for the conditions under which the observations have to be taken, we find that very inadequate attention is usually paid to the discussion of the results. Usually a mean value for each latitude, longitude, or azimuth is obtained by the computer, and he remains satisfied with this, so that when the route of another traveller follows the same line or crosses it at one or more points, it is almost impossible for the cartographer to say which of the two determinations of any position is entitled to the greater confidence. In this class of work, whether the results are obtained from absolute observations at certain points or from the direction of march, and the distance traversed, it is quite practicable to determine the range of uncertainty within which the positions of different points are laid down, and it is eminently desirable that this should always be done in order that the results of various routes which may intersect in partially known regions may be adjusted in accordance with definite mathematical processes. Some important expeditions on which infinite labour and considerable sums have been expended have presented their results, in so far as they relate to the routes which have been followed and the position of points which have been determined, in such a way that it is impossible to say with what precision such positions have been determined, and consequently any combination of these results with those of later expeditions has to be carried out empirically, since adequate data are no longer available for the employment of better and more scientific methods.

This crude and unsatisfactory way of treating observations, which in many cases have been obtained under conditions of the greatest difficulty and even hardship, is largely due to the lack of interest which geographers have shown in this part of their subject. Methods of observation and methods of computation are rarely discussed before any of our geographical societies or in any of our publications, and it is only by such discussions that the importance of properly working out the available material at a time when the observer can be consulted on points which are doubtful, or where further explanation is desirable, becomes generally appreciated.

No set of physical or astronomical observations is ever discussed or even presented without the degree of precision or trustworthiness being definitely stated; yet in geography this sound rule is too often neglected.

There are several regions where travellers' routes intersect which should provide ample material for the careful reduction and adjustment of the results. I fear, however, that there would be great difficulty in obtaining the original observations which are indispensable in such an investigation, and in the interest of research it is highly desirable that the original documents of all work of importance should be preserved and the place where they may be consulted should be recorded in the published account.

There is room in the geographical investigation of sea and land, even within the limits of the British Empire, for the employment of methods of observation and computation of the highest precision as well as of the simpler and more approximate kinds, but everyone who presents the results of his work should deem it his first duty to state explicitly the methods which he employed, and the accuracy to which he attained, in such a form that all who make use of them can judge for themselves of the degree of their trustworthiness.

In such work, while the instruments used are of great importance, too often the briefest description, such as "a 4-in. theodolite," is deemed sufficient. If the observer wishes his work to be treated seriously as a definite contribution to science we require to know more than this, and a clear account of the essentials of the instrument, a statement of its errors, and of the methods of observation adopted are the least that will suffice. The account of any expedition should treat so fully of the instruments, observations, and computations utilised to determine the positions of places visited that anyone can re-examine the evidence and form his opinion on the value of the results obtained. A mere tabular statement of accepted values, which frequently is all that is provided, is of small value from a scientific point of view. Probably one reason for this state of things is that too little attention is being paid by geographers to their instruments. Theodolites, levels, compasses, clinometers, tacheometers, plane-tables, pantographs, co-ordinatographs, planimeters, and the many other instruments which are used by the surveyor, the cartographer, the computer, have in no case arrived at a final state of perfection, but it is seldom that we find a critical description of an instrument in our journals.

Descriptions there are from time to time, but these are for the most part weak and insufficient. Not only is a technical description required, which treats fully of both the optical and mechanical details, but we need an extended series of observations with the instrument which have been made under the ordinary conditions of practical work, and these must be mathematically analysed, and the degree of the trustworthiness of the results clearly demonstrated. The description should be equally thorough and complete, including scale drawings showing the construction of the instrument as well as photographs of it. Nothing less than this is of any use to the scientific cartographer.

In this country the early advances of British instrument-makers of surveying instruments are far from being adequately represented in our national museum in a manner commensurate with their importance. The keen and enlightened zeal of geographers who are interested in this branch of the subject would doubtless quickly bring to light much still remaining that is of great interest, but which is yet unrecognised, while a closer attention to instrumental equipment would lead to improvements and advances in the types that are now employed. There is no modern work in this country on the development of such instruments, and references to their history are conspicuously rare in our journals, so that there is here an opportunity for those whose duties prevent them from undertaking travel or exploration of a more ambitious kind. In the same way, those whose opportunities of field work are few can find a promising field of study in the early methods and practice of surveying which have been discussed by many authors from classical times onwards, and for which a considerable amount of material exists.

In geodesy and surveying of high precision there is ample scope for all who are attracted by the mathematical aspect of the subject; the critical discussion of the instruments and methods employed and results obtained, both in this country and in other lands, provides opportunity for much work of real value, while its bearing upon geology, seismology, etc., has not yet been adequately treated here. The detailed history of this part of our subject is to be found in papers which have been published in the technical and scientific journals of other countries for the most part; here too little attention has been given to the subject, in spite of the large amount of geodetic work which has been executed in the British Empire, and which remains to be done in our Colonies and overseas Dominions.

The final expression of the surveyor's detailed measurements is found in the map, and the adequate representation of any land surface on a map-sheet is both a science and an art. Here we require additional work on all sides, for there is scarcely any branch of geography which offers so remunerative a field for activity as cartography. We need the co-operation of trained geographers to study requirements, and to make acquaintance with the limits of technical methods of reproduction, so that they may be in a position to deal with many questions which arise in the preparation of a map regarding the most suitable mode of presentation of data, a matter which is purely geographical, but which at the present time is too often left to the skilled draughtsman. Neither the compilation nor the reduction of maps is a merely mechanical process. The first requires great skill and care as well as technical knowledge and a sound method of treatment if the various pieces of work, which are brought together to make up the map of any considerable area, are to be utilised according to their true worth. This demands a competent knowledge of the work which has been previously done on the region, a first-hand acquaintance with the data collected by the earlier workers, and the critical examination of them in order that due weight may be given to the better material in the final result. This is not a task to be handed over to the draughtsman, who will mechanically incorporate the material as though it were all of equal accuracy, or will adjust discrepancies arbitrarily and not on any definite plan. Such preliminary preparation of cartographical material is a scientific operation which should be carried out by scientific methods and should be completed before the work reaches the draughtsman, who will then have but to introduce detail into a network of controls which has been prepared for him and of which the accuracy at all points has been definitely ascertained. Similarly in the second case the elimination of detail which must of necessity be omitted is an operation needing the greatest skill, a full understanding of the material available, and an adequate appreciation of the result which is being aimed at, such as is only to be found in a competent geographer who has made himself intimately acquainted with all the material which is available and has his critical faculty fully developed.

All these problems are well within the reach of the geographer to whom the opportunity of travel in other regions does not come, and in them he will find ready to his hand a field of research which is well worth working and which will amply repay any labour that is spent upon it. The same precise methods of investigation which are employed in the discussion of observations should be applied to all cartographic material in order to ascertain the exact standard of its trustworthiness, in which is included not only the correctness of distance and direction, but also the accuracy of the information which has been incorporated in it; and these may be brought to bear also on those early maps of which so many are preserved in our libraries in this country. In this field of study several investigators have already achieved results of great interest and value, but I think they will be ready to admit that there is here a wide and profitable field of activity for many more workers who will study closely these early maps and, not being contented with verbal descriptions, will use quantitative methods wherever these are possible.

In the study of map projections some activity has been visible in recent years, and we may hope that those who have worked in this branch of the subject will see that British geography is provided with a comprehensive manual of this subject which will be worthy of the vast importance of cartography to the Empire. The selection of suitable projections is receiving much more attention than was formerly accorded to it, but the numbers of communications on this subject which reach geographical journals are few and far between. The subject is not one which can appeal strongly to the amateur geographer, but its importance renders it imperative that the scientific geographer who realises its intimate bearing upon all his work should so arrange that the matter does not fall into the background on this account.

But it may be suggested that the lack of activity in mathematical geography is due to the somewhat specialised nature of the subject, and to the fact that the number of those who have received an adequate mathematical training and are prepared to devote themselves to geography is few. When we turn to physical geography in its treatment of the land we do find a field which has been more actively worked, for this is just the one to which the traveller's and explorer's observations should contribute most largely, and where therefore their material should be utilised

with the best results. Even here there is room for much more work of the detailed and critical type, which is not merely general and descriptive, but starts from the careful collection of data, proceeds to the critical discussion of them, and continues by a comparison of the results with those obtained in similar observations in other regions.

To take a single branch of physical geography, the study of rivers, the amount of accurate material which has been adequately discussed is small. In our own country the rainfall of various river basins is well known through the efforts of a meteorological association, but the proportion of it which is removed by evaporation, and of that which passes into the soil, has only been very partially studied. Passing to the run-off, which is more easy to determine satisfactorily, the carefully measured discharges of streams and rivers are not nearly so numerous as they should be if the hydrography of the rivers is to be adequately discussed; for although the more important rivers have been gauged by the authorities responsible for them in many cases, the results have usually been filed, and the information which has been published is usually a final value, but without either the original data from which it has been deduced, or a full account given of the methods of measurement which have been employed. For the requirements of the authority concerned such a record is no doubt adequate, but the geographer requires the more detailed information if he is to co-ordinate satisfactorily the volume discharged with local rainfall, with changes in the rates of erosion or deposition, and the many other phenomena which make up the life-history of a river. Here, too, it is usually only the main stream which has been investigated; the tributaries still await a similar and even fuller study.

In the same way we still know too little of the amounts of the dissolved and suspended matter which is carried down by our streams at various seasons of the year and in the different parts of their course.

In this one branch of the subject there is ample scope for workers of all interests in the measurement of discharges, in the determination of level, and of the movement of flood waves, in determining the amount of matter transported both in suspension and in solution, in tracing out the changes of the river channel, in following out the variation of the water-table which feeds the stream, in ascertaining the loss of water by seepage in various parts of its course, and generally in studying the hundred other phenomena which are well worth investigating, and which give ample scope for workers of all kinds and of all opportunities. There is work not only in the field, but also in the laboratory and in the library which needs doing, for the full account of even a single stream can only be prepared when data of all classes have been collected and discussed.

On the Scottish lakes much valuable scientific work has been done, and also on some of the English lakes, so that excellent examples of how such work should be done are available as a guide to anyone who will devote his spare time for a year or two in making a thorough acquaintance with the characteristics and phenomena of any lake to which he has access.

Coast-lines provide another class of geographical control which repays detailed study, and presents numberless opportunities for systematic investigation and material for many profitable studies in geography. The shores of these islands include almost every variety of type, and furnish exceptional opportunities for research of a profitable character, especially as lying on the border-line between the domain of the oceanographer on one hand and the physiographer on the other. The precise methods of representation which are possible on the land have to give way to a more generalised treatment over the sea, and the shore line is liable to be handed over to the latter sphere, so that there is much interesting and useful work open to anyone who will make an accurate and detailed study of a selected piece of coast-line, co-ordinating it with the phenomena of the land and sea respectively.

The teaching of Prof. Davis in pressing for the employment of systematic methods in describing the landscapes with which the geographer has to deal has brought about a more rational treatment, in which due recognition is given to the structure of the area, and the processes which have moulded it, so that land forms are now for the most part described more or less adequately in terms which are familiar to all geographers and which convey definite associated ideas, in the light of which the particular description is adequately appreciated. It has been urged by some that such technical terms are unnecessary and serve to render the writings in which they occur intelligible only to the few; that anyone should be able to express his meaning in words and sentences which will convey his meaning to all. There is no great difficulty in doing this, but in such descriptions to convey all that a technically-worded account can give to those who understand its terms would be long and involved on account of the numerous related facts which would be included. It is consequently essential in all accurate work that certain terms should have very definite and restricted meanings, and such technical terms, when suitably chosen, are not only convenient in that they avoid circumlocution, but when used in the accepted sense at once suggest to the mind a whole series of related and dependent conditions which are always associated with it.

The crystallisation of such geographical terms into true technical terms is an important step in the furtherance of scientific geography, but it must be done by the geographers themselves, and no means of doing this is more fruitful than the work of original research and investigation in definite areas or on specific problems.

If we now consider some of the problems of human geography we shall find the need for such systematic study to be even greater; for the variable factors involved are more numerous than in physical geography, and many of them are difficult to reduce to precise statement; the quantitative study of the subject is therefore much more difficult than the qualitative or descriptive, so that the latter is too frequently adopted to the exclusion of the former. The remedy lies, I believe, in individual research into special cases and special areas where the factors involved are not too numerous, where some of them at least can be defined with some accuracy, and where, consequently, deductions can be drawn with some precision and with an accuracy which gives grounds for confidence in the result. The settlements of man, his occupations, his movements in their geographical relations are manifested everywhere, and subjects of study are to be found without difficulty, but their investigation must be based on actual observation, and on data which have been carefully collected and critically examined, so that the subject may be treated as completely as possible, and in such a way that the evidence is laid before the reader in order that he may form his own conclusions.

It is probable that some of the lack of precision which is to be found in this part of the subject is to be attributed to the want of precision in its terminology. For many things in human geography good technical terms are required, but these must be selected by those who have studied the type of phenomenon concerned and have a clear idea of the particular conditions which they desire to associate with the term;

this is not the work of a committee of selection, but must grow out of the needs of the individual workers.

There is, it must be admitted, no small difficulty in using the same preciseness of method in this portion of the subject as is readily attainable in mathematical geography, and is usually practicable in physiography; but at any rate it is undesirable to indicate any condition as the controlling one until all other possible influences have been carefully examined, and have been shown to have less weight than that one which has been selected.

Whether the investigation deals with the settlements of man or his movements and means of communication, it is important that in the first instance problems of a manageable size should be undertaken and thoroughly treated, leaving larger areas and wider generalisations until a sufficient stock of thoroughly trustworthy material which is in the form in which it can properly be used for wider aims is available.

The relation of geographical conditions to small settlements can be satisfactorily worked out if sufficient trouble is taken and all possible sources of information, both of present date and of periods which have passed away, are utilised. Such studies are of a real value and pave the way to more elaborate studies, but we need more serious study of these simpler cases both to set our facts in order and to provide a methodical classification of the conditions which prevail in this part of the subject. Out of such studies there will grow such a series of terms with well-defined associations as will give a real precision to the subject which it seems at the present time to lack.

The same benefit is to be anticipated from detailed work in relation to man's communications and the interchange of commodities in all their varied relations. Generalised and descriptive accounts are readily to be found, and these are for the most part supported by tables of statistics, all of which have their value and present truths of great importance in geography, but the spirit of active research which aims at clearing up thoroughly a small portion of the wide field of geographical activities has unequalled opportunities in the somewhat shadowy relations between the phenomena which we meet in this part of the subject, for focusing the facts better, and obtaining a more exact view of the questions involved.

Where the geography of States (political geography) is concerned the same need for original investigation as a basis for generalisations may be seen. At the present time there is much said about the various boundaries of States, and in general terms the advantages and disadvantages of different boundaries under varied conditions can be stated with fair approximation to accuracy. But I do not know of many detailed examinations of these boundaries or portions of them where full information of all the factors involved can be found set out in an orderly and authoritative manner, thus forming a sure foundation for the generalised description and providing the means of verifying its correctness or revising it where necessary.

Perhaps there is really more scientific research in geography being undertaken by individuals than I have given credit for, but certainly in geographical periodicals, and in the bibliographies which are published annually, the amount shown is not large; neither is the number of authors as large as might be expected from the importance and interest of the subject and from the activity of those centres where geography is seriously taught. There seems to be no reason why individual research on true scientific lines should not be as active in geography as it is in geology, botany, zoology, or any other branch of knowledge; and, just as in these, the real advance in the subject is dependent on such investigations rather than on travels and explorations in little-known lands, unless these, too, are carried out scientifically and by thoroughly trained observers who know the problems which there await solution, and can read the evidence which lies before them on their route.

If research in these directions is being actively prosecuted, but the appearance of its results is delayed, let us seek out the retarding causes, if there be any, and increase any facilities that may be desirable to assist individual efforts.

Short technical papers of a thoroughly scientific character, such as are the outcome of serious individual research, are, of course, not suitable for those meetings of geographical societies where the majority of the fellows present are not scientific geographers, but should be presented to small meetings of other workers in the same or allied fields, where they can be completely criticised. The reading, discussion, and the publication of papers of this class are for geography a great desideratum, for it is in them and by them that all real advance in the subject is made, rather than by tales of travel, however interesting, if these are not the work of one trained in the subject, having a knowledge of what he should observe, and of what his predecessors have done in the same field. The regional aspect of geography in the hands of its best exponents has given to young geographers a wide and comprehensive outlook on the interaction of the various geographical factors in a region, the responses between the earth's surface and the life upon it, and the control that one factor may exercise upon another. In this form the fascination of geographical study is apparent to everyone, but I sometimes wonder whether the exposition of such a regional study by one who is thoroughly master of the component factors, having a first-hand knowledge of all the material involved, and knowing exactly the trustworthiness of each portion, impresses sufficiently upon the student the necessity of personal research into the details of some problem or phenomenon in such a way as to gain a real working acquaintance with them; or does it, on the other hand, tend to encourage generalisations based on descriptive accounts which have not been verified, and where coincidences and similarities may be accepted without further inquiry as evidence of a causal connection which may not really exist? I imagine that the student may be attracted by the apparent simplicity of a masterly account of the geographical contents and responses involved, and may fail to realise that geographical descriptions, even though technically phrased, are not the equivalent of original quantitative investigation, either for his own education or as a contribution to the subject.

For these reasons I believe that societies can do far more good in the promotion of geography as a science by assisting competent investigators, by the loan of books and instruments, and by giving facilities for the discussion and publication of technical papers, than by undertaking the investigation of problems themselves.

Among the earlier presidential addresses of this section some have laid stress on the importance of the recognition by the State of geography in education; others have represented the great part which the geographical societies have played in supporting and advancing the subject; others again have urged the fuller recognition of geography by educational institutions. I would on this occasion attach especial importance to the prosecution of serious research by individuals in any branch of the subject that is accessible to them, to the discussion of the results of such work by others of like interests, and to the publication of such studies as having a real value in promoting the advancement of scientific geography.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—Mr. H. G. Plimmer, F.R.S., has been appointed professor of comparative pathology in the Royal College of Science, South Kensington.

FOUR lectures will be delivered at Gresham College, E.C., on "Typhus Fever and Cerebrospinal Meningitis," on October 5–8, by Dr. F. M. Sandwith, Gresham Professor of Physic. The lectures are free to the public, and will begin each evening at six o'clock.

A SERIES of lectures on "The Wonder-workers of the Soil" will be given in the fellows' rooms of the Royal Botanic Society of London, Regent's Park, N.W., on October 4, 11, and 18, by Prof. W. B. Bottomley. The lectures will deal with:—(1) soil bacteria in relation to soil fertility; (2) the story of soil inoculation; (3) the discovery of auximones (accessory food substances).

BY the will of Mr. W. Jackson, engineer, of Aberdeen, who left, in addition to real estate, personal estate in the United Kingdom valued at 77,052*l*., one-half of the ultimate residue of his property, which is subject to his wife's life interest, is left for the establishment of a chair of engineering in the University of Aberdeen, any balance being then applied for charitable or benevolent objects in Aberdeen.

THE Manchester Municipal School of Technology publishes separate prospectuses of its part-time courses, and those in chemistry and chemical technology and in mathematics, physics and natural science, have been received. The part-time courses include:—apprentices' day courses for engineers' and other apprentices whose employers allow them to devote one whole day per week to study; evening courses, involving attendance on three evenings a week for five years, and leading to the Associateship of the School of Technology; and other evening and part-time day classes for advanced study and research, in preparation for the external degrees of the University of London, in technological or trade subjects, in various branches of natural science, and in other subjects. Further particulars of the work of the college were given in NATURE for August 12 last (vol. xcv., p. 664).

THE new session of the Sir John Cass Technical Institute, Aldgate, E.C., which is especially devoted to technical training in chemistry, metallurgy, and physics, and in the artistic crafts, will commence on September 27th. The instruction in experimental science provides systematic courses for London University examinations in addition to the courses on higher technological instruction, which form a special feature of the work of the Institute. The curriculum in connection with the fermentation industries includes courses of instruction on "Brewing and Malting" and on the "Micro-Biology of the Fermentation Industries." A series of lectures dealing with the supply and control of power has been arranged. These will comprise lectures on "The Supply and Control of Liquid, Gaseous, and Solid Fuel," "Electrical Supply and Control," and "The Transmission of Power." In the department of physics a special course will be given on "Colloids," which will deal with the methods employed in their investigation and their relation to technical problems; also special lectures on "The Influence of Surface Tension on Chemical Phenomena." In the metallurgy department special advanced courses are provided on gold, silver, and allied metals, iron and steel, metallography and pyrometry, heat treatment of metals and alloys, and mechanical testing of metals and alloys.

THE calendar for the current session has reached us from the Merchant Venturers' Technical College, Bristol, in which the Faculty of Engineering of the University of Bristol is provided and maintained. The college aims at providing a sound, continuous, and complete preparation for an industrial career, and its work is carried out in a secondary school, in day classes, and in evening classes. The calendar gives much evidence of the success of the governors of the college in securing the co-operation and support of the employers of the district. Many engineering firms have expressed willingness, other things being equal, to give preference to students who have completed the full college course, and some are prepared to take students at reduced premiums, while others will waive premiums altogether. Many local employers exempt from overtime, on not more than three days a week, persons in their employ who attend the college evening classes. A list of such persons is sent to each firm at the beginning of the session, with a list of the nights on which they ought to attend the classes; and a monthly return of the attendances of the evening students belonging to each firm is also forwarded. The Board of Trade accepts attendance at the evening classes in engineering in lieu of a portion of the workshop service required from candidates for the Board's certificate of competency as engineer. In other ways, too, such as by gifts and loans of books and plant, the employers of labour are showing a growing interest in the useful and varied work of this important technical college.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, June 23.—Dr. A. Smith Woodward, F.R.S., president, in the chair.—Prof. Xavier **Stainier**: A new eurypterid from the Belgian Coal Measures. The discovery is recorded of a specimen of a new Eurypterus in the cores of a trial-boring for coal in Belgium. The fossil, which is in a satisfactory state of preservation, is described. A short description of the eleven Carboniferous species known up to the present is appended. The nearest form to the Belgian fossil seems to be a Pennsylvanian Eurypterus, which, nevertheless, is not identical with the former. The geological range and the evolution in time of the twelve Carboniferous eurypterids is discussed.—R. B. **Newton**: A fossiliferous limestone from the North Sea. The material was trawled from the floor of the North Sea. It presents no appearance of glaciation, so that its occurrence *in situ* seems to be highly probable. There is no record of a similar limestone from either England or Scotland. It is of highly siliceous character and full of marine shells, of which the Pelecypoda are the more prominent; there are fragments of wood in contact with the limestone which appear to show coniferous characters. Some twenty-three species of mollusca have been determined, all of which exhibit a southern facies, including a new dosiniform shell belonging to the genus Sinodia, the relationships of which are confined to the Indian Ocean regions of Southern Asia. Eighteen of the species trace their origin from the Vindobonian stage of the Miocene, ten may be regarded as extinct, whereas twelve still exist in recent seas. The majority of the species are fairly evenly distributed in both the Coralline and the Red Crag formations of East Anglia, although it is thought that the rock must be of older age than Red Crag. Additional support is given to this view, because such shells as *Arcoperna sericea*, *Tellina benedeni*, and *Panopaea menardi* are not known of later age in this country than the Coralline Crag. The occurrence also of extinct

gastropods, which are characteristic of the Upper Miocene or Messinian deposits of northern Germany, constitutes further evidence in favour of a greater antiquity for this limestone than that of the Red Crag; it is, therefore, considered to be of Coralline Crag age. —W. R. **Jones**: The origin of the tin-ore deposits of the Kinta district, Perak (Federated Malay States). Certain tin-ore-bearing clays occurring in the Kinta district have been described as being of glacial origin, and the tin-ore which they contain as having been derived from "some mass of tin-bearing granite and rocks altered by it, distinct from and older than the Mesozoic Granite" (that is, than the granite now *in situ* in the Kinta district). These clays are stated to have furnished a more valuable horizon on climatic evidence than can be afforded by limited collections of fossils in rocks far removed from Europe. The importance is urged of the origin of these clays in a country where, on one hand, they yield an important part of the world's output of tin-ore, and where, on the other, they have been used as the horizon on which to base the geological age of rocks which cover about a third of the surface of the Malay Peninsula. If of glacial origin, a vast tin-field remains to be discovered. The object is to show that all the tin-ore found in these clays is derived from rocks now *in situ* in the Kinta district; that it is not necessary to bring in glacial action to explain and to show that a simple interpretation may be given to the geology of the Kinta district. The sources of the tin-ore are:—(1) the stanniferous granite of the Main Range; (2) other granite outcrops known to carry cassiterite; (3) the granitic intrusions in the phyllites and schists; and (4) the granitic intrusions traversing the limestone. The angularity of the boulders and of the tin ore in some of these clays is due (1) to weathering *in situ* of the phyllites and schists, which then sink on the dissolving limestone underneath; (2) to soil-creep effecting the same result; (3) to the breaking up of the weathered cassiterite-bearing boulders in the alluvium. More than 90 per cent. of the ore worked in the Kinta district is obtained from mines situated at less than a mile from granite or from granitic intrusions.

BOOKS RECEIVED.

Tables for Converting Shillings, Pence, and Farthings into 7 Places of Decimals of a Pound; and for the re-Conversion of Decimals. Pp. 8. (London: C. and E. Layton.) 1*s.* net.

Memoirs of the Indian Museum. Vol. v., No. 1. Fauna of the Chilka Lake. By N. Annandale and S. Kemp. Pp. iii+146+x plates. (Calcutta: Indian Museum.) 15 rupees.

A First Book of Arithmetic. By S. Lister. Pp. vii+258. (London: Macmillan and Co., Ltd.) 1*s.* 6*d.*

Alcohol and the Human Body. By Sir V. Horsley and Dr. M. D. Sturge. Fifth edition, enlarged. Pp. xxviii+339. (London: Macmillan and Co., Ltd.) 1*s.* net.

Science of Dairying. By W. A. G. Penlington. Pp. viii+260. (London: Macmillan and Co., Ltd.) 2*s.* 6*d.*

Laboratory Exercises, arranged to accompany "First Course in Chemistry." By Profs. W. McPherson and W. E. Henderson. Pp. x+128. (Boston and London: Ginn and Co.) 2*s.*

The Essentials of Agriculture. By W. J. Waters. Pp. x+455+xxxvi. (Boston and London: Ginn and Co.) 5*s.* 6*d.*

Diversions of a Naturalist. By Sir Ray Lankester. Pp. xvi+424. (London: Methuen and Co., Ltd.) 6*s.*

A Concise Kaffir-English Dictionary. By J. McLaren. Pp. xv+194. (London: Longmans and Co.) 3*s.* 6*d.*

A Manual of Pharmacology. By Prof. W. E. Dixon. Fourth edition. Pp. xii+467. (London: E. Arnold.) 15*s.* net.

On the Prevention of "Frost-bite" and other Effects of Cold. By S. Delépine Pp. 32. (London: John Bale, Ltd.)

Some Aspects of Industrial Chemistry. By Dr. L. H. Baekeland. Pp. 43. (New York: Columbia University Press; London: Oxford University Press.) 1*s.* 6*d.* net.

Dove Marine Laboratory, Cullercoats, Northumberland. Report for the Year ending June 30, 1915. Edited by Prof. A. Meek. Pp. 59. (Newcastle-on-Tyne: Cail and Sons.) 5*s.*

Tychonis Brahe Dani Opera Omnia. Edidit I. L. E. Dreyer. Tomus II. Pp. 461. (Hauniæ: Libraria Gyldendaliana.)

John Dalton's Lectures and Lecture Illustrations. Parts i. and ii. By Prof. W. W. H. Gee. Part iii. By Dr. H. F. Coward and Dr. A. Harden. Pp. 66. (Manchester: 36 George Street.) 1*s.* 6*d.*

West of Scotland Agricultural College, Glasgow. Calendar for Session 1915–16. Pp. 242. (Glasgow: The College.)

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